SEPTEMBER 1956

Power Engineering

Special Report: FIFTH WORLD POWER CONFERENCE VIENNA, 1956

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Keeping pace with modern

These two Elliott turbine-generator units are located in an interesting new central station which was completed at a station cost of $139 per kw! The turbines operate on steam at 850 psi, 900°F. Both machines are base loaded, part of the power production being used for a local distribution system and the surplus sold as block power through a transmission interchange.

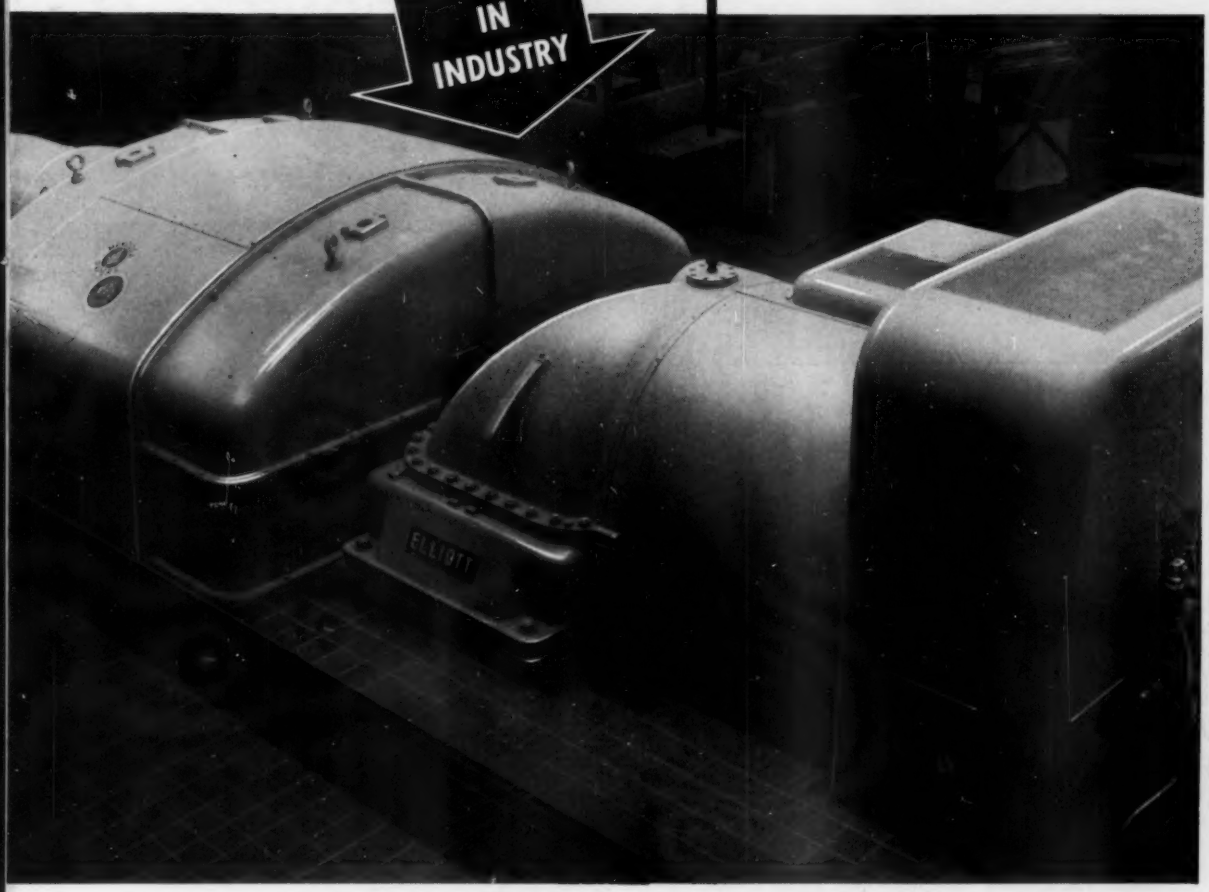
ELLIOTT TURBINE-GENERATORS

H6-5

requirements

IN INDUSTRY

This Elliott turbine-generator unit serves an industrial power plant. It extracts steam for process at 30 psig, being supplied with 400 psig, 700°F steam. This unit is an extension to an existing industrial power plant served by an Elliott back-pressure extraction unit.

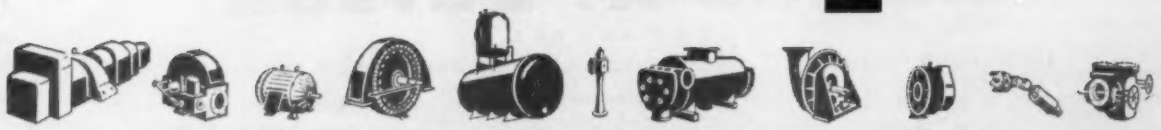


ELLIOTT TURBINE-GENERATORS meet the requirements for efficient power generation in utility stations, and the balanced power and process steam requirements of industrial plants. Their modern appearance is indicative of their sound design and superior performance. Both the steam and electrical elements are made by Elliott and the result is a coordinated unit, specifically designed to the individual needs of the plant or station.

New Engineering Bulletin...

"Fundamentals of Turbine Speed Control" contains 32 pages of the latest information on this important aspect of turbine design and performance. Write for Bulletin H-21 to the Elliott Company, Steam Turbine Department, Jeannette, Pa.

ELLIOTT Company



TURBINE-GENERATORS TURBINES MOTORS GENERATORS DEAERATING HEATERS EJECTORS CONDENSERS COMPRESSORS TURBOCHARGERS TUBE CLEANERS STRAINERS

For more data circle 501 on Post Card

In POWER STATIONS or CARGO SHIPS...

EDISON OMNIGUARD IMPROVES OPERATING EFFICIENCY

Whether you're seeking more production from electric power stations and plant equipment or greater safe speed from seagoing vessels, you will find Omniguard can help you get more efficiency from your present equipment.

Many operators are already using Omniguard, the unique temperature indicating and alarm system designed by Thomas A. Edison, Inc., as the best means of eliminating waste due to downtime, repairs and lost production.

Omniguard improves plant efficiency and lets you operate at peak capacity because it unfailingly reports when dangerous temperature conditions occur at one or more points. And does it at surprisingly low cost.

A modular system of monitoring one to an unlimited number of points simultaneously, Omniguard watches continuously. When a bearing starts heating up or a process becomes critically hot, it automatically gives a warning and/or shuts down the equipment before it is damaged.

The low cost unit is easy to install. It is non-electronic and simplifies installation and maintenance through the use of copper wiring between all components.

See for yourself. A personal demonstration can be arranged at your own plant. Take it apart. Analyze it. Find out how simply Omniguard improves operating efficiency. Just write!

Thomas A Edison

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Thomas A. Edison

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INSTRUMENT DIVISION • 37 LAKESIDE AVENUE • WEST ORANGE, NEW JERSEY

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NBP BPA

PUBLISHED SINCE 1896 FOR POWER ENGINEERS IN PRIVATE AND PUBLIC UTILITIES AND INDUSTRIAL PLANTS

ENGINEERS' PREVIEW

● NEW YORK SHIPBUILDING CORP., has received a $2,000,000 contract from the General Electric Co., for the engineering and construction of the largest pressure vessel of its type ever built.

This pressure vessel — a welded steel atomic reactor tank — will be built for the Commonwealth Edison Company's 180,000-kw Dresden nuclear power station near Chicago. The cylindrical vessel, 12 ft 8 in. inside diameter and 42 ft high, will stand upright inside a steel sphere 190 ft in diameter.

The pressure vessel will have a 3/8-in. stainless steel cladding over the inside of a 5-in. thick carbon steel welded assembly. When filled, it will hold approximately 278,000 lb of water. The vessel will weigh approximately 400 tons. It is designed for an operating pressure of 1000 psia and an operating temperature of 544.6 F.

● **RUFUS OLDENBURGER, of Rockford, Ill., joined the Purdue University faculty on September 1 as professor of engineering sciences and mechanical engineering. Mr. Oldenburger has been director of research for the Woodward Governor Co. A world-renowed authority in the fields of mathematics and automatic controls, he has had many years of experience in teaching and research. POWER ENGINEERING readers will recall with pleasure his article What the Wigglers Can Do for the Power Engineer, December 1954 issue, the only clear and understandable explanation we have ever seen of frequency response, how it works, and what you can do with it.**

● GULF OIL CORP. has released details concerning a major deposit of columbium ore discovered by Dominion Gulf Co. in northern Ontario. Preliminary drilling suggests large tonnages of the metal may be readily available at a location on Nemegosenda Lake, 17 miles northeast of the town of Chapleau. Columbium (which chemists now call niobium) is an expensive and strategically important metal especially useful in the stabilization of certain stainless steels employed for high temperature service by the petroleum, chemical and other industries.

● **ADVISORY COMMITTEE on Science Manpower, appointed by the New York City Board of Education, is considering the possibility of recommending the employment of retired scientists and engineers to meet the present shortage of science and mathematics teachers. Dr. Joseph W. Barker, President of ASME, and a member of the Advisory Committee, made the suggestion at a recent meeting of the committee.**

In order to determine if such a supply of prospective teachers exists we urge all interested scientists and engineers to write to Samuel Schenberg, Board of Education, 110 Livingston St., Brooklyn, N. Y., and enclose a brief biographical sketch of their educational qualifications and scientific and industrial experience.

● THE HANGER, the dresser, the knockout man and the middle pulpit operator sound like names from stories by the late Damon Runyon. The odds are, however, he never heard of them. For these are not trademarks of Runyon's rogues but job titles of men who help man the nation's steel mills, says American Iron and Steel Institute.

The middle pulpit operator is sharp, but his professional operations pertain to manipulating levers in a bar mill, directing hot rolled steel through various phases of the manufacturing process. And the knockout man is no dealer in unconscious states. He pries metal castings out of molds. Likewise, sartorial splendor is not a requirement for the dresser's job. The title comes from his duties of dressing or reshaping worn and damaged tools.

The gag straightener doesn't spend

his days working over the jokes of the end man. The gag straightener operates a power-driven press that straightens bent or warped steel products, while the end man, without so much as a snicker, ties wire bands around bundles of galvanized wire.

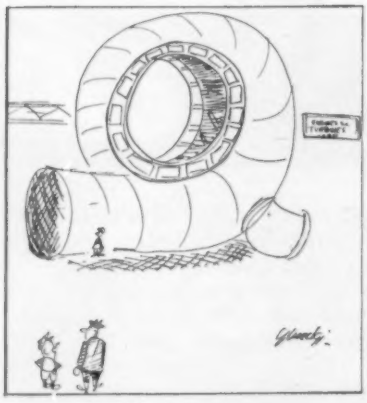
DETROIT EDISON CO. has ordered a 325,000-kw steam-turbine-generator unit — one of the largest electric power generating machines yet to be manufactured in the world — from General Electric Co. It will be installed at the utility's St. Clair power station north of Detroit, and will boost the station's electrical generating capacity to over 950,000 kw. A cross-compound, double-flow, reheat type turbine with 43-in, last-stage buckets will drive the generator. The turbine will use steam with an initial pressure of 2400 psig at 1050 F.

SCANLAN-McMAHON ASSOCIATES, INC., a new firm of consulting engineers has been established to engage in the design, installation and operation of steam power plant equipment, especially feedwater heating and conditioning equipment and combustion control systems. Much of the members' experience has been in industrial steam power plants, where the new firm plans to center its activity. Main office of Scanlan-McMahon Associates is 18724 Scottsdale Blvd., Shaker Heights 22, Ohio.

NEW STEAM TABLES covering a range from 5500 to 10,000 psia and 32 to 1600 F are now available for power systems calculations. The tables are not based on new data, but are reasonable and consistent extensions of the Keenan and Keyes tables.

Developed primarily for industry-wide use during the time required to produce authoritative tables based on experimentation, the new data were prepared by a subcommittee appointed by the Power Division of ASME.

The subcommittee made use of presently available tables and, in regions not previously evaluated, developed a table using graphical and numerical methods. The new data, plus a table devloped by United Aircraft Corp., were joined



"Wow! Pop, dig that crazy snail!"

to the Keenan and Keyes steam tables to provide data over a broader range of pressures and temperatures. The new tables are expected to meet the needs of industry until ASME, working through technical and research committees as a part of an international program, completes the studies and experimentation for an authoritative steam table to 15,000 psia and 1500 F. Copies of the paper, No. 56-SA-33, can be obtained at 50 cents each from Order Dept., ASME, 29 W. 39th St., New York 18, N. Y.

ULTRA-FAST method of using atomic "bullets" to vulcanize silicone rubber has been devised by three scientists of the Westinghouse Electric Corp. The process beams 2,000,000-v electrons at a silicone gum and almost instantly converts it into silicone rubber. Its discoverers say that the technique produces a better rubber in two seconds than conventional vulcanizing methods yield in several hours. Not yet ready for commercial application, irradiation with high-energy electrons will eventually become an important method of vulcanizing silicones industrially, they claim. Control of the process consists merely of regulating the voltage which speeds up the electrons and governing the length of time of exposure to the radiation.

STANLEY ENGINEERING CO. has moved its Chicago office from 328 S. LaSalle St., to 208 S. LaSalle St., Chicago 4, Ill.

ENGINEERING COLLEGES of the United States have experienced a net loss of three per cent of their professors to industry within a two-year period — and this at a time when the engineering colleges need 1,300 more teachers to carry the 1956–57 load.

This serious situation was reported to the ASEE by an industry committee headed by A. R. Hellwarth, Assistant to Director of Employment, The Detroit Edison Co.

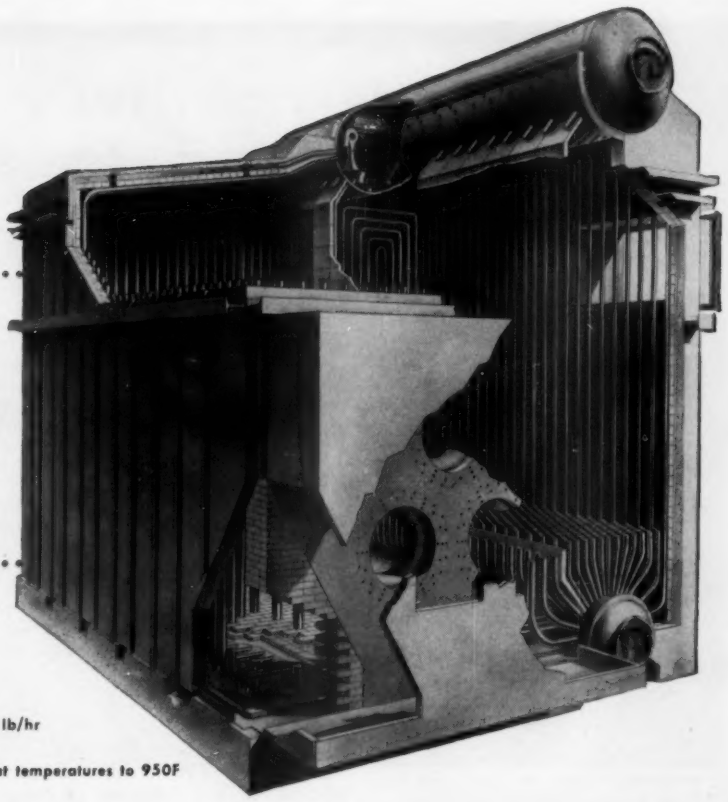
The committee, acting under the Relations with Industry Division of the ASEE, reported that during the two-year period more than 750 left engineering faculties for industry with higher salaries being the major lure. Fortunately for education, 500 left industry for teaching positions. The 150 colleges and universities accredited by the Engineers' Council for Professional Development covered by the industry committee's survey reported a gain in teaching strength from 8,000 to 8,400 during the period in spite of losses to industrial employers. The 1,300 present shortage would require the engagement of 15 additional professors or instructors for every 100 now teaching.

ARABIAN AMERICAN Oil Co. has ordered a 7,000 hp gas turbine from the General Electric Co. The unit will be installed in the Saudi Arabian desert to drive a centrifugal pump on an Aramco oil pipeline.

The Aramco order calls for the gas turbine to burn specification crude oil and to be remotely controlled. It will be mounted on two portable bases, the first of which will support the gas turbine and centrifugal pump, and the second will support air filtering equipment, oil treating equipment and auxiliaries.

CORRECTION NOTE:— And Now . . . Licensing of Nuclear Reactor Operators, POWER ENGINEERING, March 1956, page 108, column 3, line 8; value 450 kg is, of course, 990 lb and not 9900 lb as printed. We apologize for this slip of the decimal point.

Series "SC" STANDARD Steam Generator



FUELS: Oil or Gas
CAPACITIES: 50,000 to 150,000 lb/hr
STEAM PRESSURES: to 1500 psi
STEAM TEMPERATURES: Superheat temperatures to 950F

PRE-ENGINEERED FOR SAVINGS

in first cost, installation, operation, maintenance

Series "SC" Steam Generator is of the pre-engineered, standardized design, with all exterior and structural details fixed. Available in nine sizes, with capacities of 50,000 to 150,000 lbs steam per hr, it incorporates many advanced design features — as noted in the accompanying list — that make possible important savings in industrial steam costs.

Burners, controls, upper drum mountings and other equipment requiring attention are located at the front of the unit. Heat recovery equipment and fans can be placed near the operating aisle for either single or multi-unit installations, providing unusual accessibility and ease of operation.

Write us today for further information on how the Series "SC" Standard Steam Generator can meet your individual plant needs for power or process work. *Foster Wheeler Corporation, 165 Broadway, New York 6, New York.*

FEATURES AT A GLANCE

- Completely water-cooled furnace
- Over 19-foot firing depth
- Unrestricted circulation
- All-welded casing
- Fully drainable superheater
- Efficient convection surface
- Bottom supported unit
- Steam purifying system
- Full insulation

FOSTER WHEELER

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WHAT THEY TELL US

IMPACT WRENCHES CAN BE UNSUITABLE! From Tulsa, Okla. R. J. K., writes:

> I have followed your turbine overhaul series with great interest and wonder if you can answer a question about the use of impact wrenches? I have been told on several occasions impact wrenches should not be used on turbine casing stud or bolt nuts.
>
> No one has been able to explain this to me satisfactorily, and I find it hard to understand. In order to be able to withstand today's greater temperatures and pressures, modern turbine bolts and studs must be stronger than those of years ago.

We submitted the above question to the turbine department of one of the leading manufacturers, and here is their reply:

> The use of impact wrenches, although a common practice, has become a serious problem. Modern units at higher temperatures and pressures require bolt and stud material properties giving high strength at operating temperature. Impact strength of these newer materials is relatively poor at low temperature.
>
> Even though the bolts are in a low temperature section of the turbine, standardization and interchangeability as well as superior strength properties have made it common practice to use higher alloyed bolts at lower and lower levels. As a general rule, never use impact on any bolt where provision has been made for heat tightening! Use it with caution even in low-temperature areas.

JOHN C. PORTER has requested information on catalytic exhaust gas scavengers. We had not published anything recently on that subject but we sent him the following and pass it on for what it is worth:

> Manufacturer of this equipment is Oxy-Catalyst, Inc. It might be advisable to visit one of the company's installations at Sun Oil Refinery, Marcus Hook, Pa. The units cause rapid oxidation of carbon monoxide and hydrocarbon oil vapors by bringing these materials and combustion air together at a surface coated with a thin layer of catalyst. The traditional catalyst is platinum, though there are probably some variations in this material since we last checked.
>
> Catalyst units, which are somewhat like bricks in size and shape, are made up of rods gripped between metal end-plates. Porcelain coats the surfaces first, then the catalyst goes over that.
>
> To get the desired area, the number of these units stacked in a gas passage can be varied. Amount of oxidation caused by the catalyst depends on the time that each unit of gas is in contact with the catalyst, which in turn depends on the area of the catalyst-treated surface and the speed with which the gas flows over it. Hence, the oxidation can be controlled by varying gas speeds and/or the number of catalyst units.
>
> When you contact the manufacturers, it might be wise to inquire about the tolerance of these units for solids and liquids in the gas stream if you have them in the gas in question. It appears that both design and operating procedure will be influenced by such non-gaseous entrained materials.

AS NOTED ON PAGE 6, July issue, Editor Kramer gave a major address on the influence of future nuclear power in the petroleum industry, May 15, before the Petroleum Electric Power Association at Corpus Christi, Tex. Here are excerpts from his talk as reported by the Corpus Christi *Times:*

> The American economy is so huge, complex and adaptive, that the coming of power from nuclear fission will have few, if any, disruptive impacts, and will have many beneficial effects, Kramer said.
>
> In the field of electric power generation — where use of atomic energy as a substitute for conventional fuels appears most imminent — the impact of atomic energy will be of only minor significance to the petroleum industry.
>
> The impact on the gas industry might be more severe than on the oil industry, but it is not likely to modify the rate of growth in demand for natural gas.
>
> Electric utilities consume 13 per cent of the natural gas marketed. The impact would be most keenly felt in areas where cost of natural gas is highest. The most likely effect would be price reduction on gas, or a shift to areas where gas can be delivered at lower cost.
>
> If all incremental large power stations built after 1960 were atomic plants — an unlikely assumption, Kramer said — estimated loss by 1975 would equal 2.7 per cent of demand, a trifling loss.
>
> Of course, Kramer added, if atomic energy became competitive with oil and gas in the automotive field or in residential heating — also an extremely unlikely assumption — loss to the industry would eventually become severe, but no profound effect would be felt in the reasonable future.
>
> At present there is no prospect that atomic energy will be used to power automobiles or for domestic heating. Radiation shielding requirements for nuclear reactors are far too stringent to permit use of reactors on even the largest automotive vehicle, and even if lighter shielding were developed, the dangers involved in the release of radioactive materials in collisions or other accidents would be far too great.

HOW WOULD YOU CLEAN the outside of the water tubes in Heine horizontal boilers of 250 hp each under the conditions described below? J. H. S., in New Jersey, is asking for help with this problem. He explains:

> The boilers were operated at 150 psi, but for the past five years the pressure has been 70 psi. They are fired with oil. The tubes are covered with a scale of salts and oil. The boilers are not used continuously; they are shifted every morning. This gives me an idea that the brickwork doesn't get hot enough to support combustion.
>
> I should like to know what we can use to clean off the oil and scale from the tubes. We tried a scraper the shape of the tubes, but can't gain access to all of them because of the angle of the tube bank. Also, the scraper does not remove oil from the tubes.

Any suggestions? Please send them to *What They Tell Us,* POWER ENGINEERING, 110 S. Dearborn St., Chicago 3, Ill.

"You'll see why the swinging doors when he gets his dander up someday!"

IS SCHOOL OVER . . . *for any of us?*

Those of us in process control work realize that learning, too, is a continuous process. If we are to produce high quality products at minimum cost, we must apply the *right* tool for each process control job. Before we can select intelligently, however, we must learn and understand how all available tools work and how each is used. A rapidly expanding and changing technology further complicates the picture, with the result that school is never really over . . . for any of us.

An excellent instrument "refresher course" is available this year; the 11th Annual Instrument-Automation Conference and Exhibit, to convene at the New York City Coliseum, September 17th to 21st.

Instrument manufacturers will exhibit and describe their latest equipment. Classroom sessions will be conducted daily. Instrument users and manufacturers will learn more of product uses, and needs.

Milton Roy Company will be there, at booths 714, 715 and 716. We hope that we will have the opportunity to explain our equipment to you, and its application to your specific chemical metering needs. If you can't attend, then write for the "textbooks" listed below. They contain the "what", "why" and "how" of controlled volume pumping and, probably, the economical solution to your chemical feed problem.

Bulletin 455 *"Controlled Volume Pumps in Paper Making"*

Bulletin 953 *"Controlled Volume Pumps in Industrial Water Treating"*

Bulletin 1253 *"Controlled Volume Pumps in Process Instrumentation"*

Milton Roy Company, *Manufacturing Engineers*, 1300 East Mermaid Lane, Philadelphia 18, Pa.

Engineering representatives in the United States, Canada, Mexico, Europe, Asia, South America and Africa.

milton Roy
CHEMICAL FEED SYSTEMS

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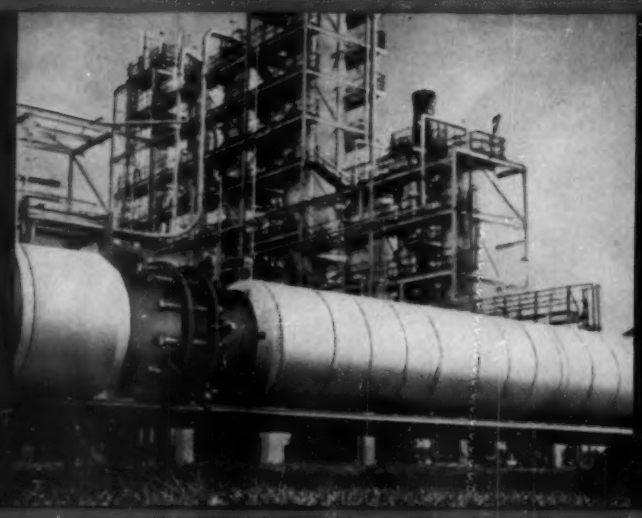
why engineers

IN THE AIR...

These Gun-Pakt Joints in overhead line are some of 22 Yarway Gun-Pakt Joints installed at a large Southern hospital.

ON THE GROUND...

One of 37 Yarway Gun-Pakt Expansion Joints installed at giant oil refinery. Gun-Pakt Joints at this refinery range in size from 1½" to 14".



UNDERGROUND...

Yarway Gun-Pakt Joints installed in manhole of new steam distribution line of large Eastern utility. 12 Gun-Pakt Joints 12" and 18" are installed in this line; scores of other Gun-Pakts up to 24" are used by this utility.

YARWAY

go for Gun-Pakt Expansion Joints

Engineers go for Yarway Gun-Pakt Expansion Joints because:

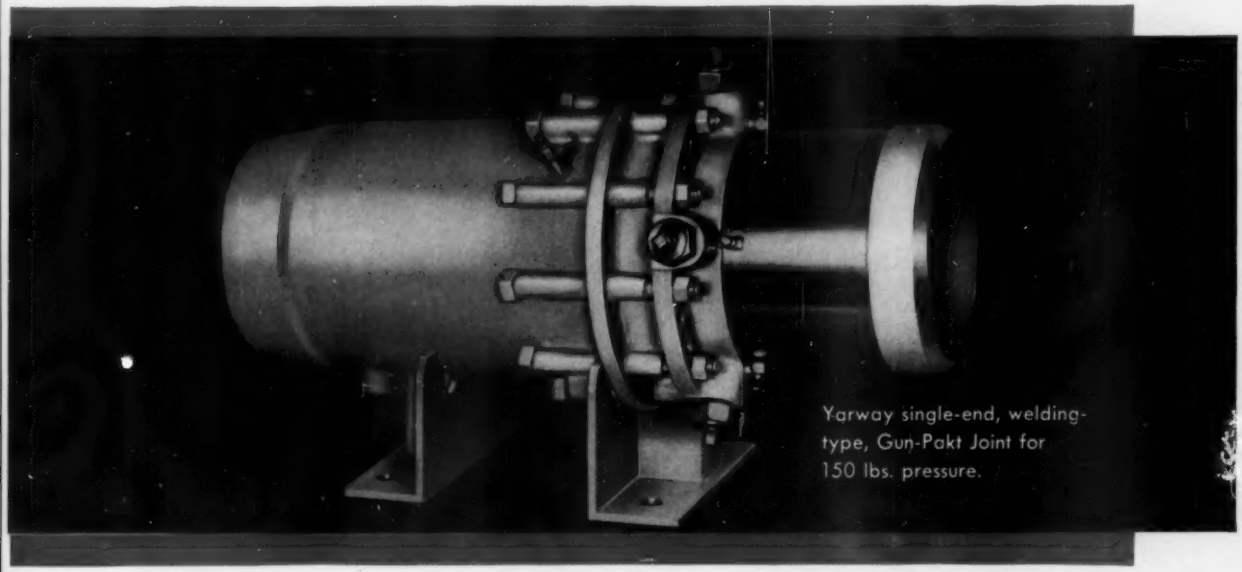
NO SHUTDOWNS. With Gun-Pakt Joints when new packing is needed, it is added under full steam pressure, right on the job—no unpacking, no shutdowns, no service interruptions.

FEWER JOINTS NEEDED. With Gun-Pakt Joints you need fewer joints per length of pipe line, with traverses up to 12″ single and 24″ double.

LONG SERVICE—NO METAL FATIGUE. Gun-Pakt Joints give long, trouble-free service life—no fatigue failures.

LOW MAINTENANCE. Maintenance records show the costs for servicing Gun-Pakt Joints are very low. One utility reports only 65 cents per year per joint—another reports less than half that.

Leading institutions, central heating stations and industrial plants "go for Gun-Pakt" again and again. Write now for latest bulletin EJ-1914.



Yarway single-end, welding-type, Gun-Pakt Joint for 150 lbs. pressure.

A few typical users of Yarway Gun-Pakt Expansion Joints

UTILITIES	INSTITUTIONS	INDUSTRIAL PLANTS
Detroit Edison Company	Central Heating Plant, Washington, D.C.	Ford Motor Co. of Canada
Georgia Power Company	Delaware County (Pa.) Prison	General Motors Corp. (Buick Division)
Ohio Edison Company	N.Y. Hospital & Cornell Medical Association	General Motors Corp. (Oldsmobile Division)
Rochester (N.Y.) Gas & Electric Co.	Purdue University	Westinghouse Electric Corp.
Pacific Gas & Electric Co.		
Philadelphia Electric Co.		

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Penna.
BRANCH OFFICES IN PRINCIPAL CITIES

GUN-PAKT EXPANSION JOINTS

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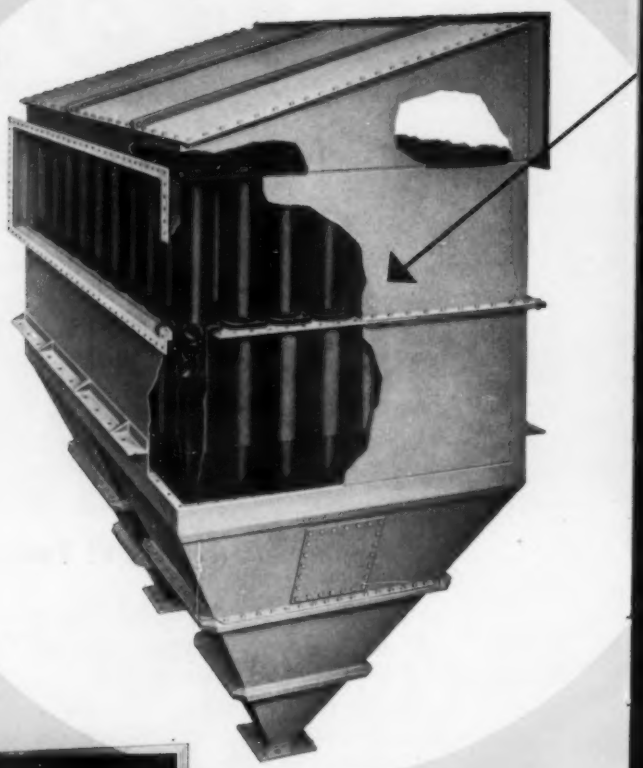
NEW

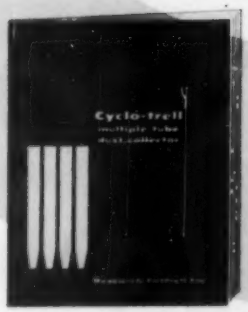
Cyclo-trell

Multiple Tube Dust Collector



Here are a few brief facts on Research's new multiple tube mechanical collector.

- Collection efficiencies are higher, for a given pressure drop, than other conventional multiple tube collectors.
- Gas flow per tube is higher than conventional units. This means fewer tubes per collector and lower total cost for a given capacity.
- Cyclo-trell's design is based on Research's 45 years experience in manufacturing gas cleaning equipment. As the largest manufacturer of electrical precipitators in the world, Research-Cottrell has engineered and built many combination units consisting of precipitators and mechanical collectors.
- Bulletin M gives complete details on design features, efficiency, capacity and detailed dimensional drawings. Write for your copy today.



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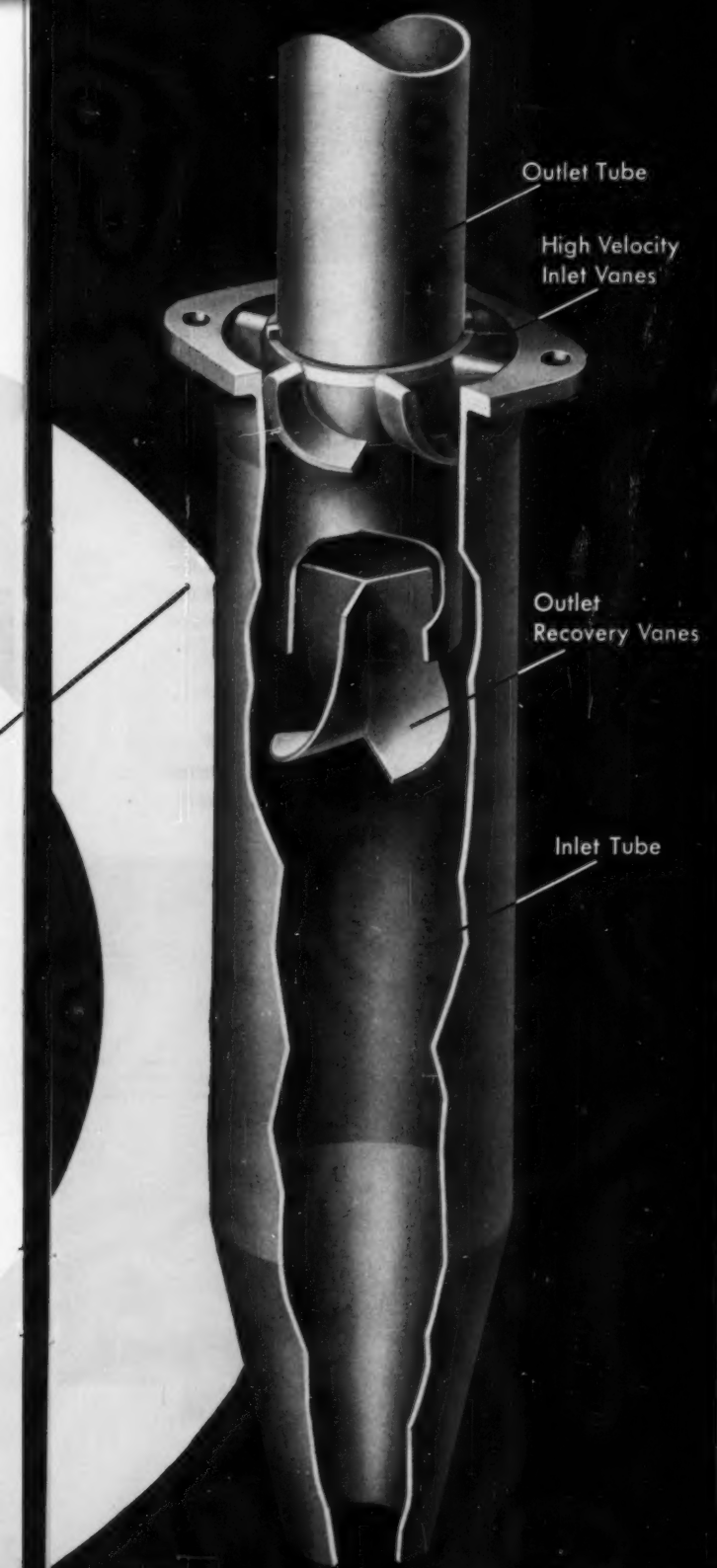
RC188



Higher Collection Efficiency

An important reason for Cyclo-trell's higher collection efficiency is the aerodynamically shaped inlet vane unit. The purpose of these vanes is to produce a fast spiral of incoming gas. The faster these gases spin, the greater the centrifugal force on the suspended dust.

After testing many types and curvatures of vanes, Research found that this new design resulted in less turbulence, greater centrifugal force and higher collection efficiencies.

Greater Gas Handling Capacity

To develop a higher gas flow capacity than other multiple tube collectors, Research's engineers developed the following design features. First, by using a 10″ diameter inlet tube, instead of the conventional 9″ tube, the flow of incoming gas was increased.

The next step was to straighten the gas flow as it entered the outlet tube, since a spiraling gas stream creates more resistance than a straight through flow. In the Cyclo-trell this spiral is eliminated, and energy is recovered in the outlet tube by the Outlet Recovery Vanes. By positioning these vanes below the tube, rather than inside the tube, resistance has been further reduced.

This combination of features means greater gas flow per tube, fewer tubes per collector and a lower total cost for a given capacity and efficiency.

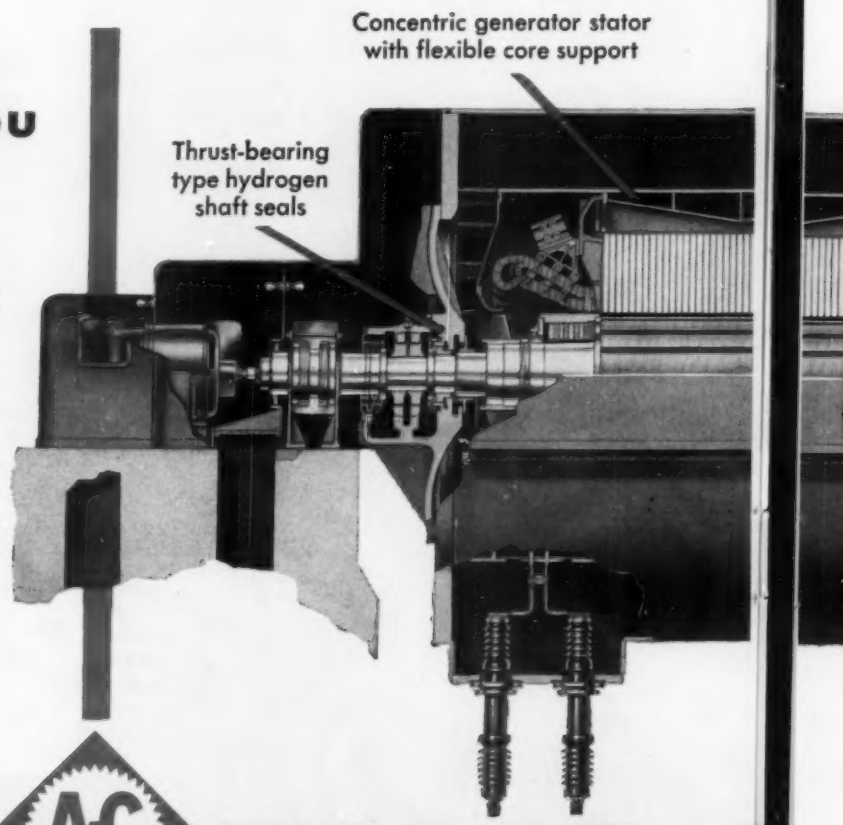
Research-Cottrell, Inc.

Main Office and Plant: Bound Brook, New Jersey • 405 Lexington Ave., New York 17, N. Y.
Grant Building, Pittsburgh 19, Penna., 228 No. La Salle St., Chicago 1, Ill. • 111 Sutter Bldg., San Francisco 4, Cal.

Now in Ratings

Here is the turbine rotor for one of the 16,500-kw units now being built. For this 850-psig, 900-F AIEE-ASME turbine, rotor shaft and wheels are of integrally forged construction.

Allis-Chalmers Turbines Give You MORE Modern Design Features



CUTAWAY VIEW of 16,500-kw unit shows the development of impulse turbine design for larger ratings.

A-C ALLIS-CHALMERS

ALLIS-

Production up to 16,500 Kw

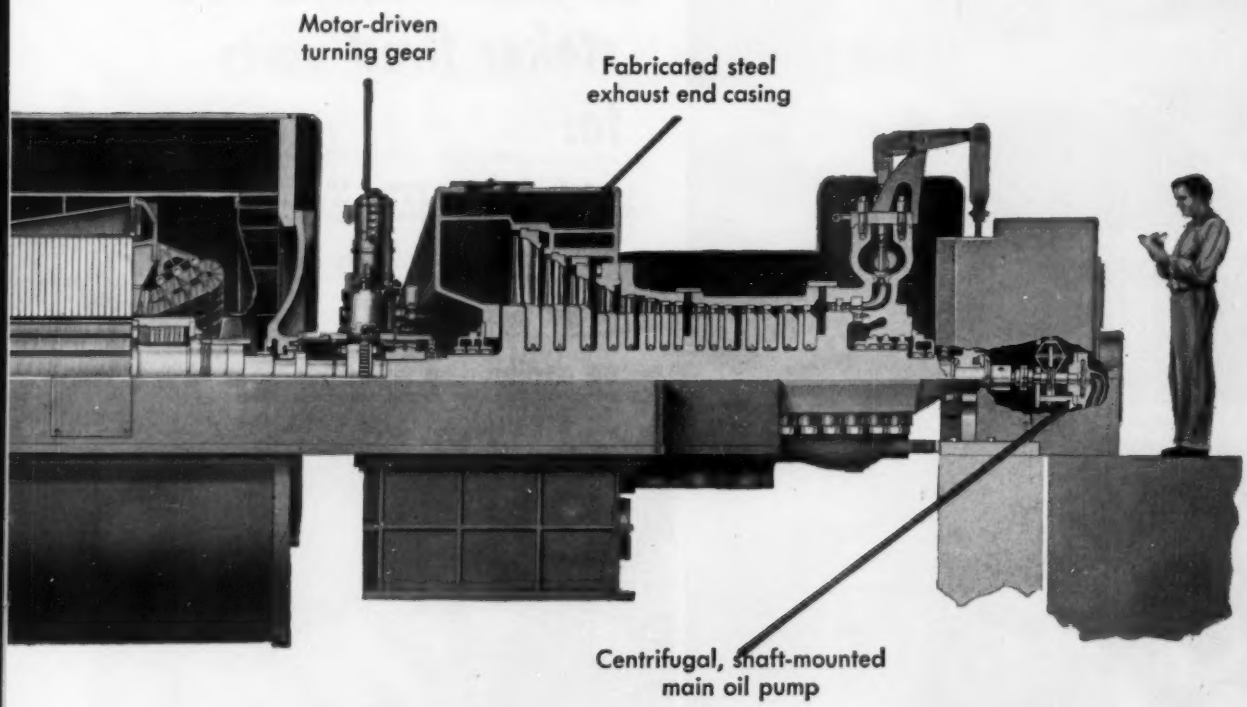
NEW Large WA-Series Turbines Offer

- **Advanced Design Features**
- **Simplified Installation**
- **AIEE-ASME and NEMA Ratings**

NEW WA-Series steam turbine-generator units now being manufactured include the 10,000-kw NEMA standard rating as well as 12,650-kw and 16,500-kw AIEE-ASME preferred standard condensing ratings. The 16,500-kw units have hydrogen-cooled generators.

Incorporated in the design are time-proved labyrinth steam sealing, removable external glands, high chrome alloy steel buckets and nozzles, reliable governing system, and unit shipment and installation — plus additional large turbine and generator features.

To get MORE information on economical, dependable units 2000 kw and larger, call the nearest A-C district office, or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wis.



CHALMERS

LIVE BETTER ELECTRICALLY

A-5127

For more data circle 507 on Post Card

Power MODERNIZATION PROGRAM

another POWER MODERNIZATION CITATION WINNER . . .

at its Bendix Products Division
South Bend, Indiana

Bendix
AVIATION CORPORATION

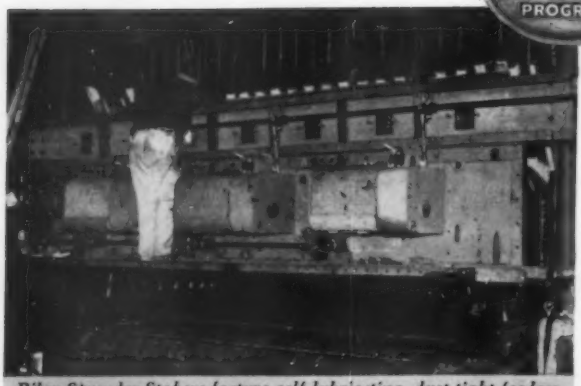
replaced two old boilers with two modern RILEY stoker fired units to:

cut fuel costs 19% per 1000 lbs. of steam

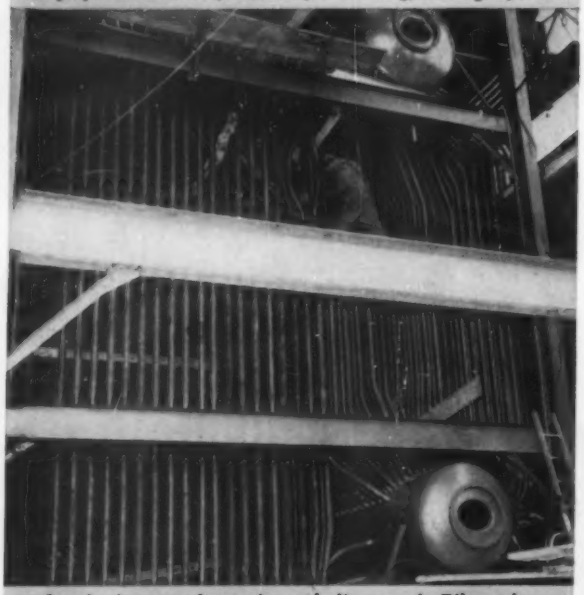
boost efficiency from 70% to 82%

lower maintenance costs 80%

up availability from 50% to 96%



Riley Spreader Stokers feature self lubricating, dust-tight feeders.



Care is given to tube spacing and alignment in Riley units.

Two views of the Bendix firing aisle show Riley Traveling Grate Hydraulic Drives and overhead coal conveyor system.

. . . and another example of why it pays to modernize . . . and with RILEY BOILERS and RILEY FUEL BURNING EQUIPMENT

SINCE installing two 80,000 lb/hr. Spreader Stoker fired Riley units, savings to Bendix Products Division at South Bend, Indiana in coal consumption have amounted to many thousands of dollars per year, enough to pay for the modernization within a comparatively short time. This added to savings in production due to increased availability, and savings resulting from an 80% decrease in cost of maintenance means still shorter write-off time of investment . . . and with Riley equipment an assurance of many years of dependable, low cost operation.

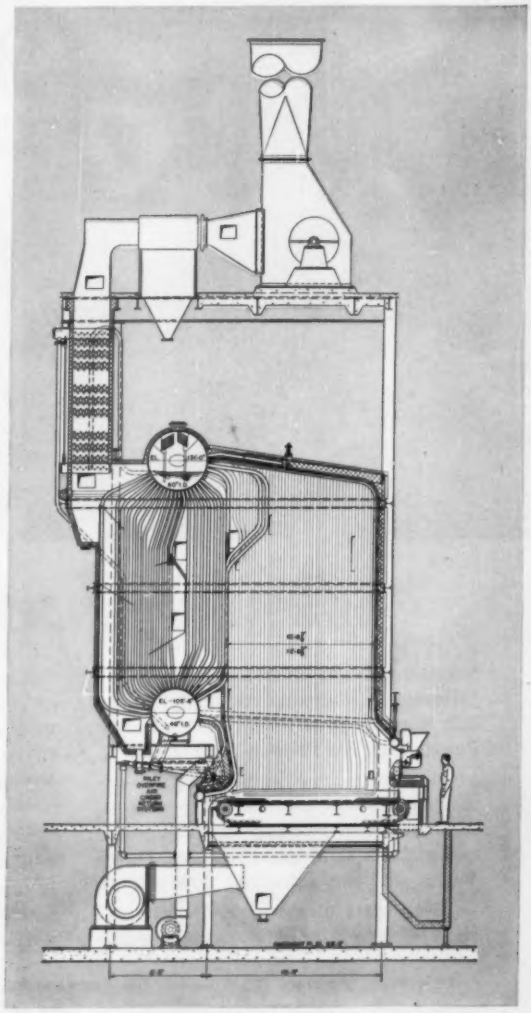
Nature of the Bendix Modernization Program

- Replace two 511 H. P. Boilers with two 80,000 lb/hr. Riley Units fired by Riley Traveling Grate Spreader Stokers.
- Revamp building to accommodate boilers and coal handling equipment.
- Install 500 ton overhead bunker and coal elevator-conveyor system.
- Increase capacity of water softener, filter, boiler feedpumps and air system.
- Install new steam headers, coal unloading shelter and ash washer.

Problems Solved to Maintain Operation During Modernization

- Demolish tall brick stack.
- Support of roof of building while removing building columns.
- Excavate and form new footings under walls for coal bunker.
- Pour new foundations for boilers

Bendix is to be congratulated for its 1955 POWER MODERNIZATION AWARD winning program. Of the twelve winners in this contest Riley equipment was featured by five companies: Bendix, Pennsylvania Railroad, Garlock Packing Co., Carbide and Carbon Chemicals Co., and The Flintkote Company.



Two Riley Traveling Grate Spreader Stoker Fired Units, capacity 80,000 lbs/hr; 160 psig design, saturated; Riley Continuous Tube Economizer.

Mr. W. E. Sanders, Manager of Production Service Departments, lights off with Paul E. Rudbeck, Power Plant Superintendent.

A survey of your plant by a consulting engineer could show ways of making surprising savings in your power costs.

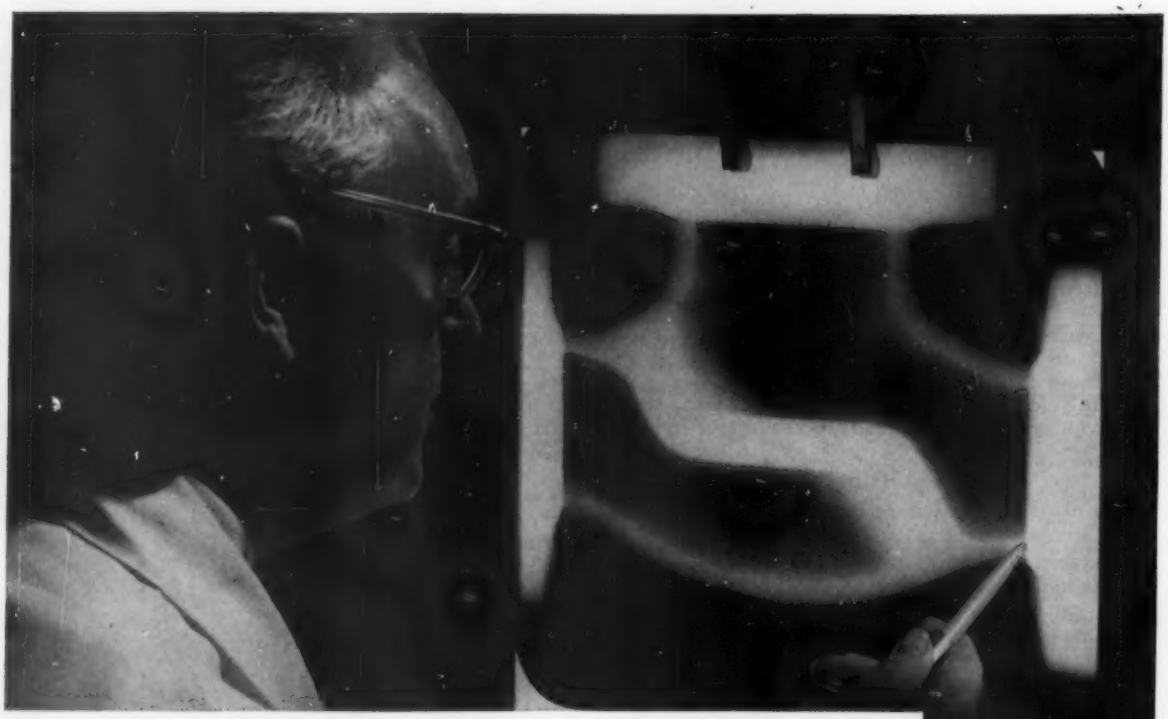
RILEY

Stoker Corporation

WORCESTER, MASSACHUSETTS

Sales Offices: Worcester, New York, Philadelphia, Buffalo, Washington, Pittsburgh, Cleveland, Detroit, Chicago, Cincinnati, Charlotte, New Orleans, Atlanta, St. Louis, Kansas City, St. Paul, Houston, Denver, Salt Lake City, Los Angeles, San Francisco, Portland, Seattle.

For more data circle 508 on Post Card



Inside story:

Valves may look alike on the surface. Their performance is another story. And the inside story of Powell Valves is that *every* Powell Valve has *Performance Verified.*

X-ray and gamma ray inspection—examining the very structure of the metal itself—are two of the many ways that Powell can make absolutely certain that Powell Valves will give *dependable* flow control.

Every part of every valve must pass rigid inspection. As a final step in manufacture, every Powell Valve is subjected to *an actual line test.* Because of Powell's pains-taking quality control, valve repair is cut to the minimum and plant shut down through valve failure is substantially reduced. Records from refineries, power and industrial plants the world over prove it.

Consult your Powell Valve distributor. If none is near you, we'll be pleased to tell you about our COMPLETE *quality line* which has PERFORMANCE VERIFIED.

The Wm. Powell Company, Cincinnati 22, Ohio . . . 110th YEAR

PERFORMANCE PV VERIFIED

FIG. 19003 WE—900-Pound Steel Pressure Seal Gate Valve.

FIG. 11365 WE—Steel Pressure Seal Horizontal Lift Check Valve for 1500 Pounds W.S.P.

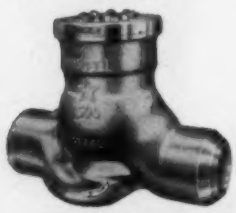
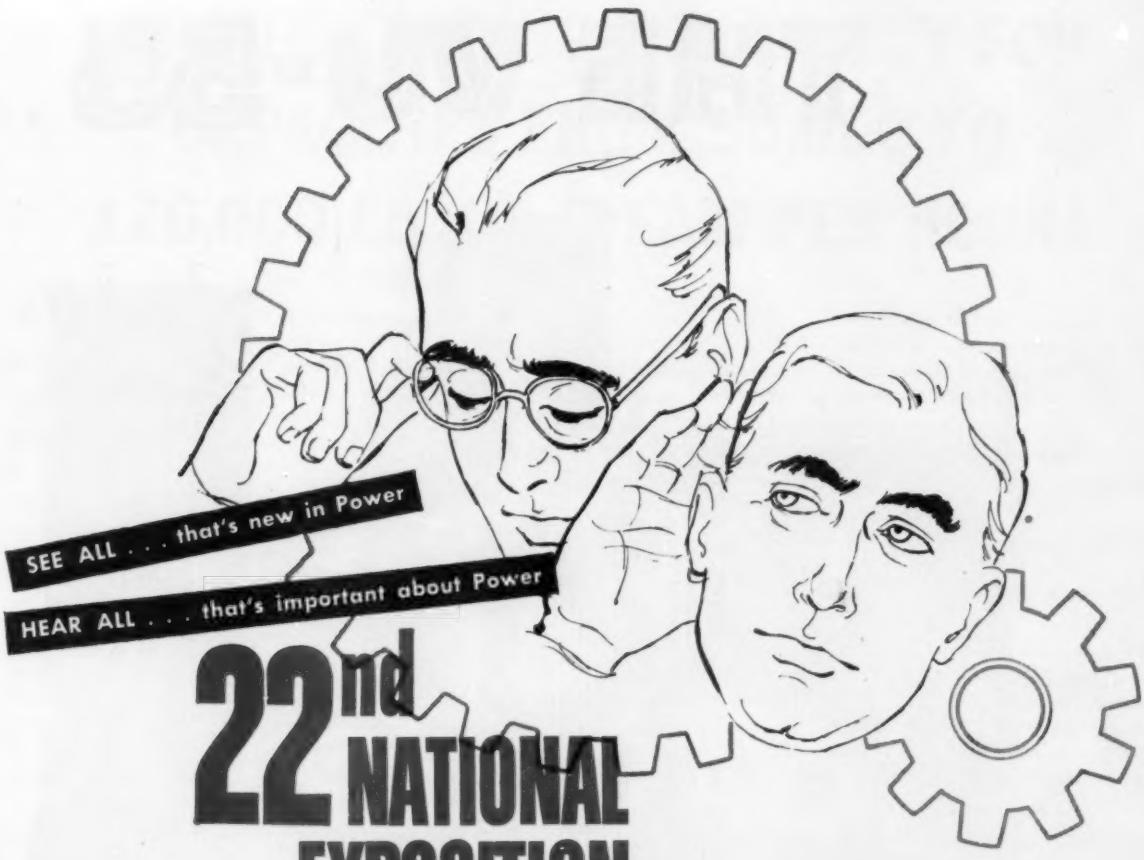


FIG. 3031 WE—Steel Globe Valve for 300 Pounds W.S.P.

POWELL VALVES

BRONZE, IRON, STEEL AND CORROSION RESISTANT VALVES.

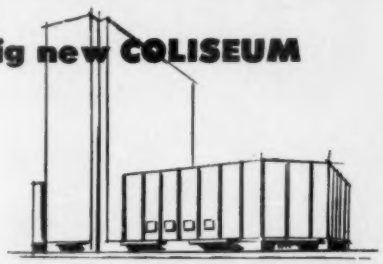
For more data circle 509 on Post Card



22nd NATIONAL EXPOSITION of POWER & MECHANICAL ENGINEERING

Under auspices of ASME

Nov. 26-30, 1956, In New York's big new COLISEUM



What's new in the field of power? Plenty, and here's where you'll find out about it—at the biggest Power Show of them all in the newest showplace of them all—New York's Coliseum.

Efficient production and use of Power? Hundreds of up-to-the-minute absorbing exhibits will show you what's new and answer your questions, help solve your special problems. You'll meet with scores of men with the same interests, you'll exchange information, you'll get vital new ideas. If your interest is Atomic Energy, you'll find a whole section devoted to this subject.

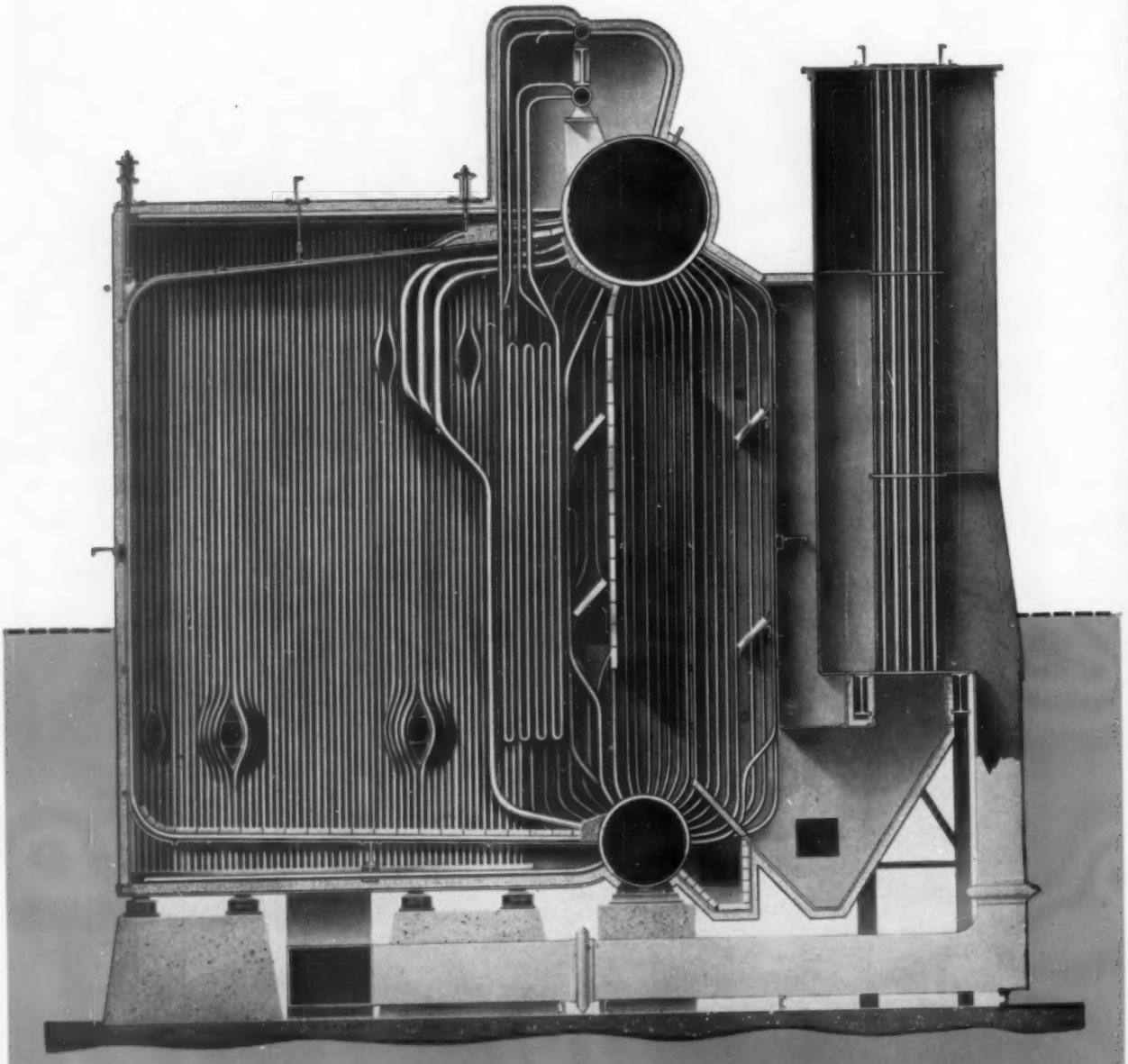
Every convenience for comfortable show-going is incorporated in the new Coliseum. Plan now to come—and bring your associates. Save time—write today for advance registration to:

22ND NATIONAL EXPOSITION OF POWER & MECHANICAL ENGINEERING
480 Lexington Ave., New York 17, N. Y.

3504

MANAGEMENT: **INTERNATIONAL EXPOSITION COMPANY**

THE VU-55...



SPECIFICATIONS

Sizes—Five sizes ranging from 50,000 to 120,000 lb of steam per hr.
Pressures—250 up to 750 psi (all sizes)
Superheat—as required up to 300° F
Fuels—oil or gas, pressure fired
Heat Recovery—Tubular or Regenerative Air Preheater

AN OUTSTANDING BOILER BUY FOR CAPACITIES FROM 50,000 TO 120,000 LB. OF STEAM PER HOUR!

The VU-55 — a development of Combustion's basic Vertical Unit design—offers features never before available in a boiler of its capacity range. If your steam needs call for a unit in the 50,000 to 120,000-lb class, you will find it worth while to consider the economic and operating advantages assured by these VU-55 features:

TANGENTIAL FIRING. More than 20 years of application experience have established the exceptional advantages of tangential firing, illustrated and briefly described below. About 90 percent of Combustion's large utility installations use this advanced method of firing.

DOUBLE WALL, PRESSURIZED CASING. The latest development in casing construction for pressure firing of boilers in the size class of the VU-55, this casing as illustrated and described below, is designed to assure life-time tightness with minimum heat loss. Pressure firing permits the elimination of an induced draft fan with its attendant operating and maintenance costs.

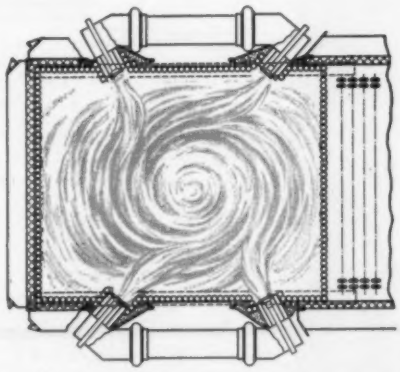
TANGENT FURNACE TUBES. The VU-55's furnace tube arrangement provides complete heat-absorbing, water-cooled protection on all furnace walls. Furnace maintenance is minimized, refractory expense is eliminated, heat absorption rates per sq ft are higher.

SIMPLIFIED ERECTION. Shop assembly of furnace wall panels and boiler screen tubes saves time and money in handling, transportation and erection.

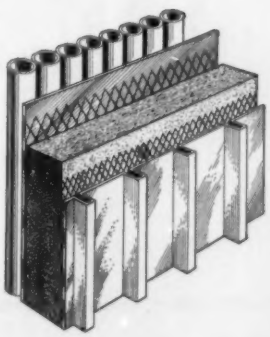
HIGH STEAM QUALITY. Equipped with a large (60-in.) steam drum, the VU-55 has generous water capacity and steam reservoir space. C-E drum internals assure high quality steam at all ratings.

STREAMLINED EXTERIOR. The over-all appearance of the VU-55 reflects the efforts of its designers to achieve a completely unobstructed casing, while retaining adequate access wherever required and every facility for convenient operation. There are no outside downcomer tubes, and ducts from air heater to burners are beneath the furnace floor.

Your request for further information on the VU-55 Boiler will receive prompt attention.



PLAN VIEW OF FURNACE showing arrangement of burners for tangential firing. Flame streams from the four burners impinge upon one another at high velocity, creating a turbulence unattainable by any other method of firing. The result is rapid and complete combustion. As the gases spiral upward, they sweep all furnace heating surfaces, assuring a high rate of heat absorption.



PERSPECTIVE OF FURNACE WALL. Construction consists of tangent tubes backed up successively by welded steel panels, 4 inches of high quality insulating material and an outer steel casing formed as shown to provide adequately for expansion and assure ample strength. Low heat loss and the tightness required for pressure firing are assured by this double-wall construction.

COMBUSTION ENGINEERING

Combustion Engineering Building, 200 Madison Avenue, New York 16, N. Y.
CANADA: COMBUSTION ENGINEERING-SUPERHEATER LTD.

B-938

STEAM GENERATING UNITS; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; HOME HEATING AND COOLING UNITS; DOMESTIC WATER HEATERS; SOIL PIPE

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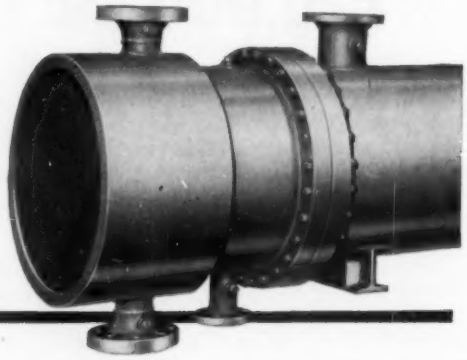
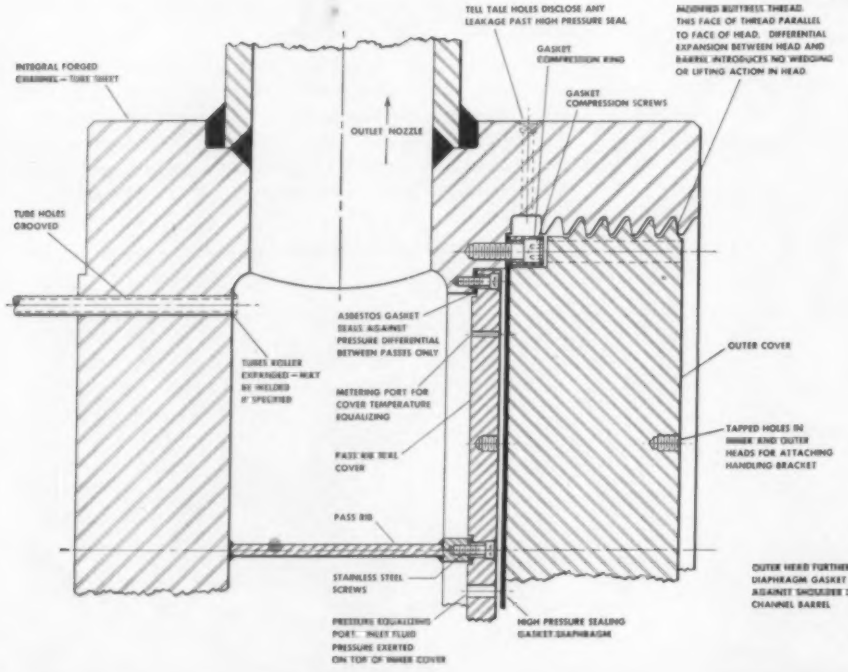
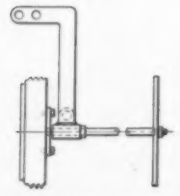
INSIDE FACTS

on the simplicity, safety and operating advantages of the exclusive Ross High Pressure Closure Design*

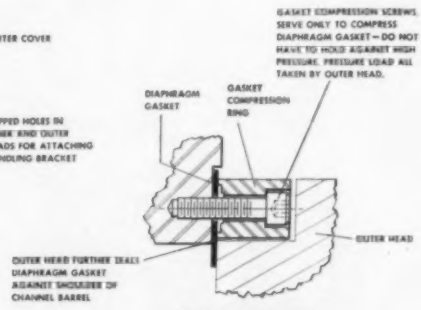
- Simpler design.
- Fewer parts to handle.
- High pressure seal unaffected by hydrostatic loads.
- Greater safety factor.
- Sudden load fluctuations no problem.
- Outer cover cannot corrode and bind . . . easily removed.
- Easily opened for inspection.




TELL TALE HOLES DISCLOSE ANY LEAKAGE PAST HIGH PRESSURE SEAL
GASKET COMPRESSION RING
GASKET COMPRESSION SCREWS
OUTLET NOZZLE
TUBE HOLES GROOVED
ASBESTOS GASKET SEALS AGAINST PRESSURE DIFFERENTIAL BETWEEN PASSES ONLY
METERING PORT FOR COVER TEMPERATURE EQUALIZING
PASS RIB SEAL COVER
PASS RIB
OUTER COVER
TAPPED HOLES IN INNER AND OUTER HEADS FOR ATTACHING HANDLING BRACKET
STAINLESS STEEL SCREWS
HIGH PRESSURE SEALING GASKET DIAPHRAGM



TYPICAL COVER HANDLING BRACKET FOR HORIZONTAL UNIT


GASKET COMPRESSION SCREWS SERVE ONLY TO COMPRESS DIAPHRAGM GASKET—DO NOT HAVE TO HOLD AGAINST HIGH PRESSURE. PRESSURE LOAD ALL TAKEN BY OUTER HEAD.
DIAPHRAGM GASKET
GASKET COMPRESSION RING
OUTER HEAD

DETAIL OF GASKET COMPRESSION RING FACING

NOW FOR ALL THE DETAILS,

request new Bulletin 5.6K1, mailed immediately. Write Ross Heat Exchanger Division of American-Standard, Buffalo 5, N. Y. In Canada: Kewanee-Ross of Canada Limited, Toronto 5, Ont.

ROSS

ROSS HEAT EXCHANGER PRODUCTS

*for feedwater heaters and other high pressure, high temperature exchangers

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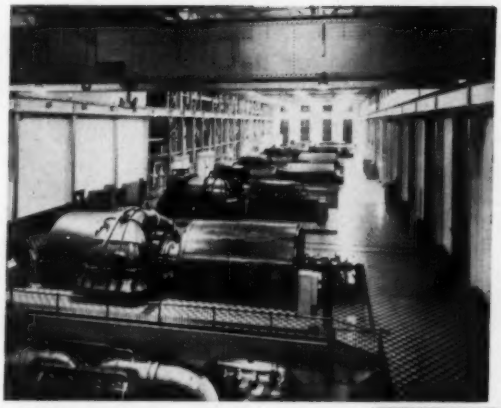
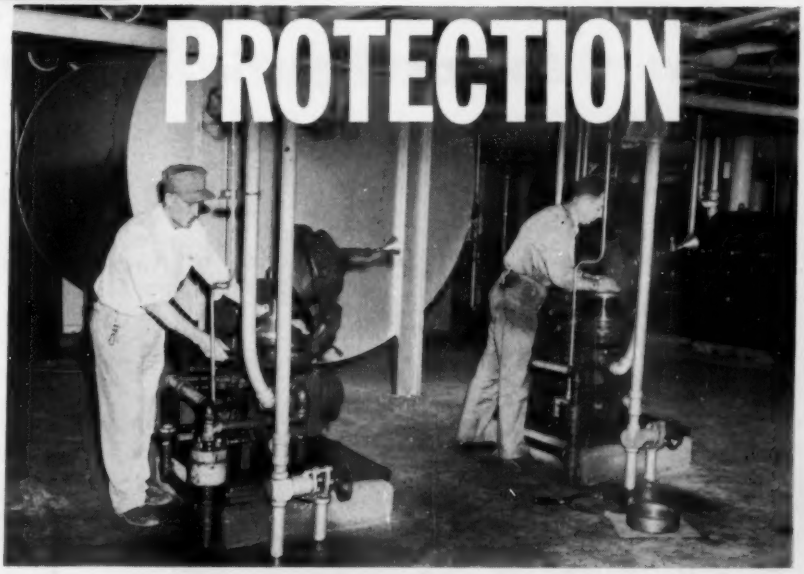
SINCE 1929 DUKE POWER HAS INSTALLED 22 DE LAVAL PURIFIERS FOR TURBINE PROTECTION



Turbine room at Duke Power Co. plant at Charlotte, N. C.



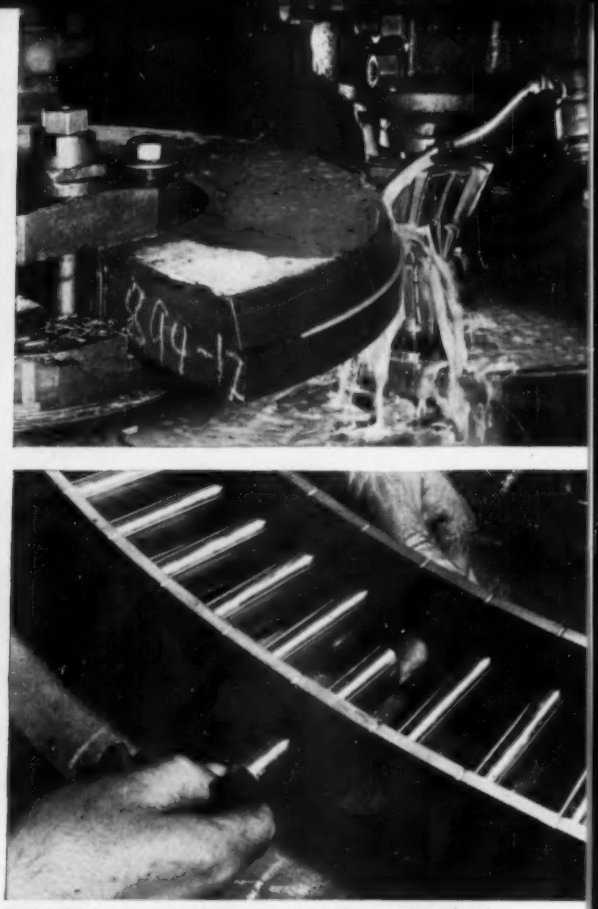
Two De Laval Turbine Oil Purifiers at Charlotte plant keep oil in prime condition . . . remove water and oxidation products . . . reduce sludge formation to minimum. They take out any trouble-making impurities . . . but do NOT remove valuable inhibitors!

DE LAVAL SEPARATOR COMPANY

THE DE LAVAL SEPARATOR COMPANY Poughkeepsie, New York • 427 Randolph St., Chicago 6 • DE LAVAL PACIFIC CO. 201 E. Millbrae Ave., Millbrae, Calif.

For more data circle 513 on Post Card

THE HIGH-PRESSURE END DIAPHRAGM WEBS are made from heavy alloy steel plates or castings. Some are ten inches thick and can withstand high pressure drops and maintain close clearances.

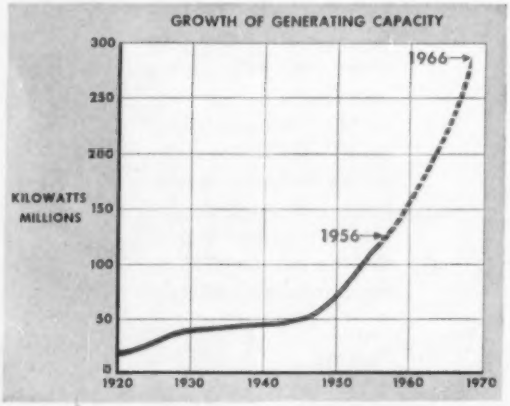


THE WEB is then carefully machined for welding (top). Nozzle partitions are machined from solid chrome-iron alloy and assembled in punched bands (bottom).

How General Electric builds sturdy nozzle-

GENERAL ELECTRIC MAINTAINS a continuing program of research on turbine diaphragms. This smoke tunnel provides a visual indication of how steam flow will follow new nozzle designs.

TO MEET TOMORROW'S EXPANDING LOADS



G.E. works with electric utilities and consulting engineers in these vital turbine-generator areas:

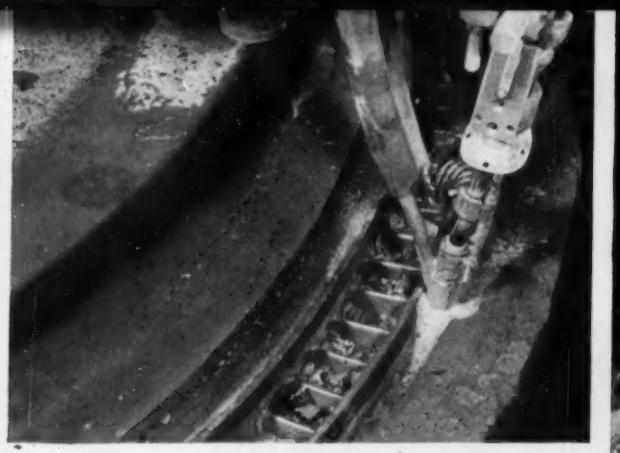
BASIC RESEARCH

APPLIED RESEARCH

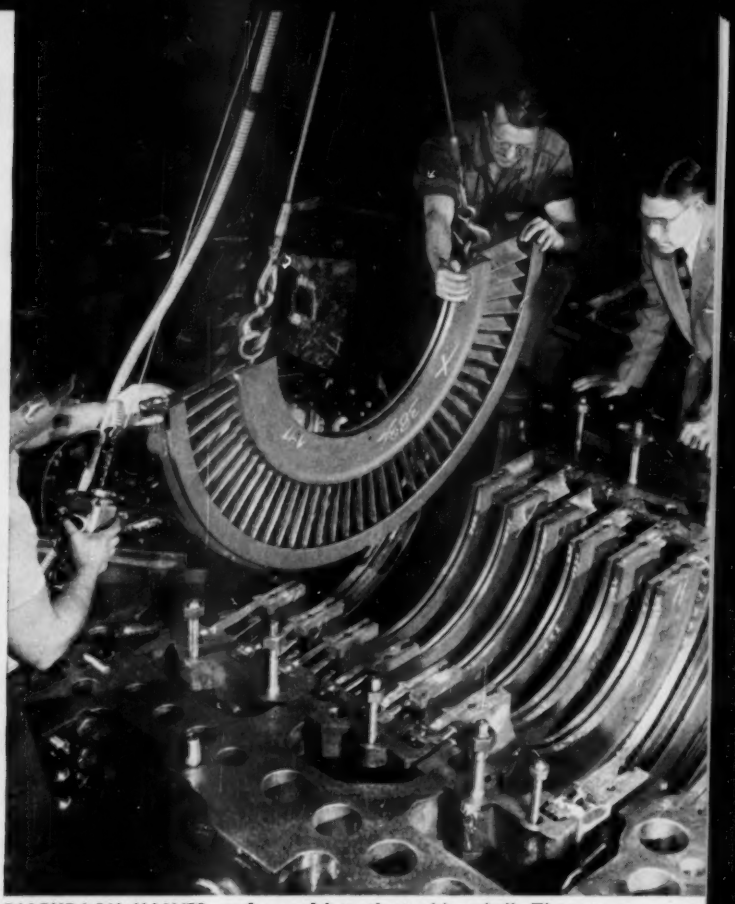
PRODUCT DEVELOPMENT: NOZZLE-DIAPHRAGMS

TESTING

MAINTENANCE



THIS NOZZLE assembly is welded to the web and outer ring (top). A finishing operation puts a high polish on the partitions for a smooth steam path (bottom).



DIAPHRAGM HALVES are lowered into the turbine shell. The rotor is then assembled and the upper shell containing the top half of the diaphragm is added to form a series of complete compartments.

diaphragms to reduce turbine maintenance

TOUGH CONSTRUCTION HELPS PROTECT STEAM PATH AGAINST DESTRUCTIVE FOREIGN MATERIALS

Internal damage to the steam path can be a costly and time consuming cause of turbine shutdown. Should large amounts of foreign material enter the steam path whole rows of buckets and partitions might be severely damaged. This could mean a long and costly outage.

TO HELP GUARD against a long outage, General Electric builds turbine nozzle-diaphragms of tough, sturdy construction. And here's how they help. Should foreign materials enter the steam path, these rugged nozzle-diaphragms "compartmentalize" damage to a small area. This greatly simplifies bucket repairs or replacement.

GENERAL ELECTRIC MANUFACTURES these diaphragms from solid castings or plates carefully machined to shape. Nozzle partitions are machined from solid chrome-iron alloy and welded to, or cast integral with, the webs. These partitions must direct the steam flow at the proper angle and velocity to the adjacent buckets.

In this and many other areas of research G.E. is working with electric utilities and consulting engineering firms to design the power makers for tomorrow's load growth. For more information on General Electric turbines write for GER-905, Large Steam Turbine-Generator Department, General Electric Company, Schenectady 5, N. Y. 254-40

Progress Is Our Most Important Product

GENERAL ELECTRIC

For more data circle 514 on Post Card

The Power Plant Engineer Said: "I WOULDN'T KNOW..."

INQUIRING REPORTER: So you use Nalco System water treatment ... How often are your boilers turbined?

ENGINEER: I wouldn't know—only worked here seven years. *

* You recognize the Engineer's answer as a twist on the old one about *How-often-do-you-get-a-raise-around-here.* Our excuse for bringing it up is that the engineer's answer applies to hundreds of plants using Nalco water treatment. New plants, starting boilers from scratch with Nalco, report years on line, *billions* of pounds of steam generated in boilers that have *never* been turbined ... and probably never will be. Older plants, where turbining was as routine as checking the draft gauges, now open boilers only to show the inspectors.

These Nalco *results* can quite possibly be duplicated in your plant, regardless of the kind or severity of your water treatment problems ... or the size of your operation. Write or phone, now, for a fast start toward permanent water treatment security.

NATIONAL ALUMINATE CORPORATION

6224 West 66th Place • Chicago 38, Illinois

Telephone: POrtsmouth 7-7240

In Canada: Alchem Limited, Burlington, Ontario

THE Nalco® SYSTEM ... Serving Industry through Practical Applied Science

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HELPFUL BULLETINS

VALVES AND FITTINGS

101 Solenoid Valves — Condensed Valve Catalog 201, 32 pp, presents latest designs in company's line of two-, three- and four-way solenoid valves. Compiled for easy reference, this booklet contains engineering information, flow charts, operation and construction of details. Fully illustrated, it also includes prices and a selection chart. Automatic Switch Co.

102 Automatic Valves — In concise language and with the aid of simple, easy-to-follow drawings, 8-pp Bulletin G-4 explains how the piston operating principle of company's automatic valves, and other design features, contributes to dependable, economical, and efficient operation. Golden-Anderson Valve Specialty Co.

103 For Directional Control — Three- and four-way directional control valves for fluid power systems up to 3000 psi are described in 16-pp Bulletin 80300. Included are details of valve body construction and function of standard and special plungers. Four styles of operators — mechanical, manual, hydraulic and solenoid pilot — are featured. Each is described, with type designation, dimensions, J. I. C. symbols given. The Oilgear Co.

104 Bonnetless Valves — Such advantages as simplicity of design, fewer parts, elimination of body-bonnet joint and gasket leakage, elimination of stud nut and union corrosion, lower maintenance cost, and others are described in 16-pp Catalog 700 on bonnetless forged steel valves. Photos and cutaway drawings point out design features, and flow charts, capacity tables, and material specifications are included. Velan Engineering Ltd.

105 Unions and Valves — Catalog 56, 22 pp, contains complete engineering data on company's line of hot forged steel products, including regular and double extra heavy, orifice, lug nut, male and female, stainless steel and alloy unions, and single union, double union and spring controlled check valves. Cutaway views show design features and tables list pertinent data. Catawissa Valve and Fittings Co.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 125 and 126.

106 Steel Fittings — Bulletin A-3-56, 28 pp, contains complete dimensional, engineering and application data on company's forged steel screw-end and socket-welding fittings for high pressure service. Features organization of data in simplified charts and covers materials selection, pressure ratings, pipe thread and socket-welding specifications and hydraulic and mathematical tables. W-S Fittings Div., H. K. Porter Co., Inc.

MECHANICAL POWER TRANSMISSION

107 For Multiple V-Drives — Catalog MVD-56, 18 pp, describes company's Ful-Grip Q-D Sheaves, standard Multi-V sheaves, and made-to-order sheaves, and gives practical information on the handling of sheaves as well as dimensions and descriptions. Illustrations, tables and charts give full data. Maurey Mfg. Corp.

108 Variable Speed Drives — Sixteen-pp Bulletin 1600-B7 P describes variable speed drives with touch control, with information on features, operating principle, design, component parts, definition of engineering terms and formulas, selection tables and graphic illustrations of drive dimensions. Also covers modifications and accessories. Worthington Corp.

109 On Flexible Shafts — Engineering Bulletin 570 shows typical installations using flexible shafting. Furnishes information on shafting from 1/8 to 1 5/16 in. for power drive or remote control. Charts aid in correct size selection for a particular job. Standard fittings and ferrules available for integral design connections are shown. Power drive shafts with built-in bearings are illustrated. Stow Mfg. Co.

PUMPS, PUMPING

110 Close-Coupled Pumps — Eight-pp Bulletin 710.1 shows construction features and provides performance data and specifications on close-coupled centrifugal pumps. These pumps are adaptable to general industry as well as chemical plants, refineries, paper mills, breweries. Pumps in this line are single stage with enclosed impeller, available in 20 sizes with capacities to 2000 gpm, heads to 400 ft. Goulds Pumps, Inc.

111 Centrifugal Pumps — Bulletin W-306-B3DP features engineering data on company's centrifugal pumps for air conditioning systems, available with heads to 120 ft and capacities to 240 gpm. Graphically illustrates dimensions and sizes, and includes rating curves. Worthington Corp.

112 Cradle-Mounted Pumps — Twenty-pp Form 7223-B covers cradle-mounted centrifugal pumps having capacities from 5 to 2800 gpm and pressures of 10 to 525 ft total head. A tabulation of pump types with their rating aids in selection, and a cross-section view points up design features. Various models are described along with their applications, and typical installation views provided. Also, performance tables and dimensions are included, and available modifications are described. Ingersoll-Rand Co.

113 Metering Pumps — Twelve-pp Booklet 600 features metering and proportioning pumps as used in water conditioning. Illustrates typical installations for the injection of inhibitors in water conditioning systems. Includes pump specifications, a table listing chemicals most commonly used in water conditioning, what they are used for, and pump construction best suited to inject them. Hills-McCanna Co.

114 Hydraulic Pump-Motor — Catalog Section G-112 contains specifications and ordering information on the Gerotor hydraulic pump-motor. Diagrams, photos, and performance charts are included. Gerotor May Corp.

115 For Pumping, Sewage Treating — Manual 1114 is a 16-pp reference manual dealing with pumping and sewage treatment equipment. Gives detailed information for determining capacities of, and selecting vertical wet pit pumps and pneumatic ejectors. A selector guide lists products, model numbers, and specific technical bulletins covering these products. A section of booklet is devoted to sewage and industrial waste treatment systems. Yeomans Brothers Co.

WATER, WASTE HANDLING

117 Tray-Type Deaerator — Publication 4652 describes a tray-type deaerator designed to provide complete deaeration, and tells how continuous maintenance of perfect heat balance eliminates waste of steam or heat and how more heat can be recovered and returned to boiler if exhaust steam is used. Cochrane Corp.

118 Get Rid of Algae — How to rid water systems, in power plants and air conditioning, of algae and slime is told in two informative pamphlets. Product described is a dry chlorine formulation available in granular or tablet form. Folders explain how it works, give directions for use. Olin Mathieson Chemical Corp.

119 Waste Treatment Unit — A low-cost package unit for removal of solids from waste water by settling is covered in Bulletin 315-92. Rex Verti-Flo, bulletin explains, is a self-contained packaged unit in a steel tank featuring ease of operation and designed to handle industrial plant water clarification, process water reclamation, antipollution. Chain Belt Co.

ELECTRICAL

120 Motors for Many Jobs — Bulletin 1878 is a colorful revamped publication including a more complete line of company's motors. Descriptions and illustrations cover open-type Uniclosed designs, totally-enclosed and explosion-proof types, Varidrives, Synchrogears, and right-angle models; also vertical motors and Verticlosed hollowshaft types. U. S. Electrical Motors Inc.

121 Wound Rotor Motor — Construction details of wound rotor motors for a variety of applications where high starting torque with low starting current is needed are described in Bulletin 51 B 8195 A. Photos and cutaway drawings illustrate important features. Allis-Chalmers Mfg. Co.

122 Hollow Shaft Motors — Bulletin GEA-6521, 6 pp, discusses design features and performance of company's vertical pump motors, 7½ through 30 hp. A cutaway view illustrates important design and operation features of the pump motors. General Electric Co.

123 Synchronous Motors — Construction features of company's large end-shield bearing synchronous motors, which feature combined protection and accessibility, are described in Bulletin 05B8305.

Standard construction features, modifications and excitation are covered. Allis-Chalmers Mfg. Co.

124 All-Weather Motors — Bulletin 470-A features company's 10- and 15-hp all-weather high torque, capacitor-run single phase motors. Describes such features as protection against weather, debris, small field animals, others. Robbins & Myers, Inc.

125 Aerial Cable — Sixteen-pp Publication 19-266 features aerial cable for electric utility and industrial power distribution systems, including preassembled, preassembled reverse-lay, field assembled and messenger and ring type. A discussion on application of aerial cable and when to use aluminum conductors is included, as well as comparative costs of aerial versus open wire installations and other related tables. General Electric Co.

126 Interlocked Armor Cable — Publication 19-555, 18-pp, covers interlocked armor cable designed specifically for primary and secondary feeders in industrial power distribution systems and for generator leads, station auxiliaries, and station control cables in electric power stations. Components needed for a complete system are listed, along with installation information and other data. General Electric Co.

127 Aluminum Conduit — Major advantages of company's aluminum electrical rigid conduit are discussed in 8-pp Form AD 283, including corrosion resistance, light weight, nonsparking and nonmagnetic properties. Includes installation suggestions, dimensions and weights. Aluminum Co. of America.

128 Load Center Transformers — — Twelve-pp Bulletin CS-1000 contains engineering data, weights and dimensions on company's complete line of load center transformers. Covers construction features on liquid-filled and dry-type units for indoor or outdoor installation, with illustrations and drawings of typical applications. Standard accessories are also covered, as well as ratings available, types of core and coil assemblies. Kuhlman Electric Co.

129 Specifying Relays — This 12-pp article on specifying relays covers various factors to be considered in selecting an electrical relay for a given application, including circuit characteristics, type of switching, actuation power, operating speed, duty cycle, life expectancy, environmental conditions, physical requirements and cost. Photos of various types of equipment are included. American Machine & Foundry Co.

130 On Industrial Capacitors — The Capacitor Digest (Bulletin GED-2978), is a collection of some of the best, recent trade-magazine stories on the subject of industrial capacitors. Stories in the digest point out how industrial capacitors installed at the load in a plant can pay a high return in power cost savings, released additional capacity and better operating conditions. General Electric Co.

131 Storage Batteries — Bulletins 168 and 334 describe pocket plate nickel cadmium storage batteries, showing economic advantages and giving tabular data for various applications. Bulletin 334 covers control and standby batteries for switchgear, standby power and emergency lighting, and Bulletin 168 describes batteries for starting heavy-duty gas, gasoline and diesel engines, operating fire pumps, standby generators and remote power sources. Nickel Cadmium Battery Corp.

132 Key Switches — Described in this 24-pp catalog are key switches for electromechanical switching purposes. Fully illustrated, provides necessary ordering information on cam lever keys with surface or flush mountings, twist type and push button keys on individual mountings or in strips of standard size. Also gives data on key mountings and key boxes, including diagrams of key box applications. Stromberg-Carlson Co.

133 Stationary Power Batteries — Exide-Tytex batteries in plastic containers for stationary power applications are described in Form 5907. Lists advantages of these batteries and discusses design features including the positive plate combination of active material and a grid made of Sylvium — a new and durable alloy. Exide Industrial Div., The Electric Storage Battery Co.

134 Improved Regulators — Eight-pp Bulletin GEA-6385 introduces company's RM (repetitive manufacture) line of induction voltage regulators. Describes two regulators which, at lower cost, replace nine former station ratings. The RM regulators are designed to give Class I accuracy as defined by ASA, and to carry increased future loads without change of equipment — and on existing feeders to carry more load at lower cost. General Electric Co.

135 Splicing Kit — Bulletin 90-B1 contains instructions and application information for company's splicing kit 90-B1. Describes advantages, gives step-by-step instructions for using kit, and contains chart outlining electrical and physical properties of the epoxy resin. Minnesota Mining and Mfg. Co.

FANS, VENTILATING

136 Propeller Fans — Forty-pp Bulletin A-109B contains new fan sizes not shown in company's previous catalog on propeller fans. Also provides revised air deliveries, specifications, performance data and dimensional drawings on the entire line. Standard propeller, utility, cool-blast, Lo-Noise, reversible and By-Pass duct fans, intake air units and unit heaters are shown. Hartzell Propeller Fan Co.

137 Exhaust Fans — Axial flow direct-connected exhaust fans for a variety of applications are described and illustrated in Bulletin 500, 8 pp. In addition to several types of general exhaust fans, bulletin also shows Mancooler fans, roof ventilators and penthouse units. Performance ratings and specifications are provided, also hints on installation, and a table of average air changes covering boiler rooms, engine rooms, machine shops, warehouses, others. M & E Mfg. Co.

138 Roof Ventilators — Sixteen-pp Bulletin A-112, revised, covers manufacturer's full line of roof ventilators. Provides information on a reversible roof ventilator, also penthouse Vertijet, rotary and other models. Sizes, specifications, performance data and dimensional drawings are included in the bulletin. Hartzell Propeller Fan Co.

139 Air Diffusers — Twelve-pp Bulletin K-27 gives selection and performance data on Kno-Draft square and slotted series air diffusers. Illustrated with photos of various models and of typical installations, this booklet provides dimensions and selection charts, suggestions for use of each type of diffuser. Special features of the slotted diffusers, for interiors requiring a linear type of outlet, are detailed. Connor Engineering Corp.

INSTRUMENTS AND CONTROLS

140 Remote Control System — Plug-in package remote control system for two-position discreet operation of starters, pumps, valves, loaders, gates, operators is featured in this illustrated brochure. Describes operation and includes specifications. The Sparks-Withington Co.

141 Data on Regulators — Revised Bulletin 1059, 12 pp, includes photo-illustrated descriptions of company's new 250-lb type high-pressure model of the "1001" regulators which offer a maximum capacity of 200 psi and outlet pressure range from 5 to 60 psi and are adaptable to natural, manufactured or LP gas. Bulletin gives complete maximum capacity tables, along with explanation of the tables and ratings based on them. Meter and Valve Div., Rockwell Mfg. Co.

142 Dial Thermometers — Features and general specifications for company's dial thermometers with anti-parallax Maxivision dial are covered in 8-pp Bulletin 149. Selection tables are included, as well as dimensional drawings. Manning, Maxwell & Moore, Inc.

143 Flow Computer — Pressure compensated, totalizing flow computer is described in Catalog 310398, with illustrations, detailed specifications and applications of the flow computer for use in any situation calling for orifice measurement of gas. Librascope, Inc.

144 Temperature Regulator — Bulletin 500 offers complete information on Stacon Series V self operating temperature regulator recommended for steam, water, gases and all fluids not corrosive to brass. Contains such data as weights and dimensions, pressure and temperature ratings, accessories, construction and performance characteristics. A. W. Cash Co.

145 Automatic Coal Scale — Bulletin 0352A, 16 pp, describes operation, components and auxiliary equipment for two models of high-speed automatic coal scales. Feeding, weighing, and discharge cycles of the scale are illustrated, as well as such components as belt feeder, weigh hopper, housing and controls, and operating levers. Typical installations are illustrated. Richardson Scale Co.

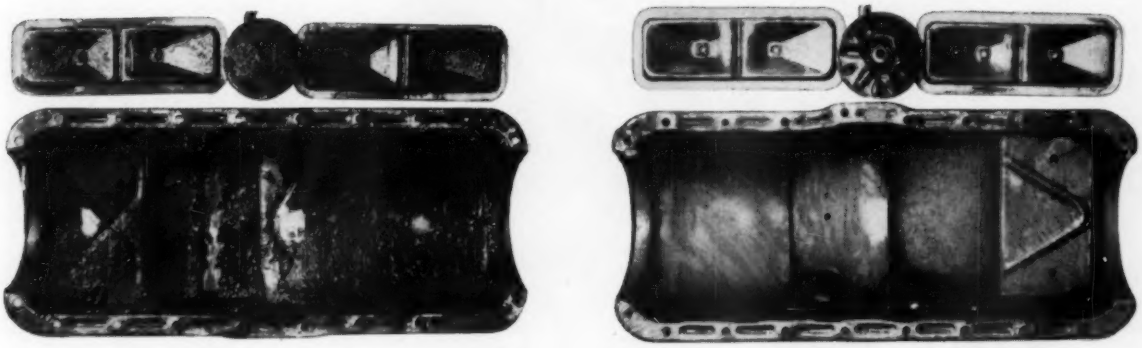
MATERIALS HANDLING

146 Conveyor Belt Carriers — Bulletin 355, 16 pp, describes carriers designed for general service on all types of belt conveyor installations, including die cast, non-contact labyrinth seal, spun end interchangeable rollers, jig welded steel frame, precision type ball bearings and Timken roller bearings. Photos, diagrams, cutaway drawings, and dimension tables are included. Stephens-Adamson Mfg. Co.

147 Motor Scraper — Form MS-1105, 16 pp, tells design, engineering, construction and operating feature stories of company's TS-260 motor scraper. Specifications are included, along with photos showing engine, power train, steering, braking and other parts. Construction Machinery Div., Allis-Chalmers Mfg. Co.

PROOF POSITIVE...

of SINCLAIR Diesel Oil Superiority!



This is actual photographic proof of the superiority of Sinclair Diesel Lubricants. On the left is a truck engine sump in which an ordinary oil was used. The clean sump on the right reflects conditions when a Sinclair Diesel Oil, SUPER TENOL, was used. This same top quality lubrication performance can be expected from all Sinclair Diesel Oils... *because Sinclair has the exact oil to match your engine's requirements!*

Sinclair RUBILENE®— These high viscosity index oils, refined by Sinclair's famed Phetone Process, have a long history of outstanding performance and are extensively used in stationary Diesel power plants today.

Sinclair RUBILENE HD— These high viscosity index oils contain additives which provide excellent detergent – dispersant properties, oxidation resistance, bearing corrosion prevention and anti-foam qualities. They are especially suitable for stationary Diesels as well as the higher speed Diesels used in industrial plants.

Sinclair GASCON®—These naturally detergent, straight mineral oils are recommended for slow, medium and high speed Diesels where carbon deposits, engine cleanliness and easy, low temperature starting is important.

Sinclair GASCON HD— Heavy duty detergent type oils compounded with selected additives to provide extra detergent dispersant properties, bearing corrosion prevention, oxidation resistance and anti-foam characteristics.

Sinclair TENOL®, SUPER TENOL and TENOL EXTRA—A series of heavy duty, detergent—dispersant type, high viscosity index oils refined by the Sinclair Phetone Process. Recommended for all high speed automotive fleet Diesel engines, and for some engines of late design in stationary, portable and marine service. All three series contain varying degrees of additive concentrations necessary to give outstanding performance no matter what the service condition under which your Diesel operates.

For further information about Sinclair's trouble-proof Diesel lubricants, see your Sinclair Representative, or write Sinclair Refining Company, Technical Service Division, 600 Fifth Avenue, New York 20, N. Y. *There's no obligation.*

SINCLAIR

DIESEL OILS

For more data circle 516 on Post Card

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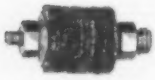

Sectional wire brush.

Air valve for one-man operation.

Rotojet Junior Tube Cleaners are unusually powerful for their size and weight. They are fed easily through the tubes with the operating hose, and can be shifted quickly from tube to tube. Their convenient size, speed, and ease of operation offer a marked contrast with external cleaners costing many times more.

An air valve directly behind the Rotojet motor permits one-man operation. Very little headroom is required, and either vertical or horizontal tubes can be cleaned.

Simplicity of Rotojet design and precision construction assure long service, efficient use of power, and freedom from trouble. Economical brushes, cutters, and scrapers meet practically any requirement.

Send for Bulletin J-410.

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. . .Outstanding Among This Month's Catalogs

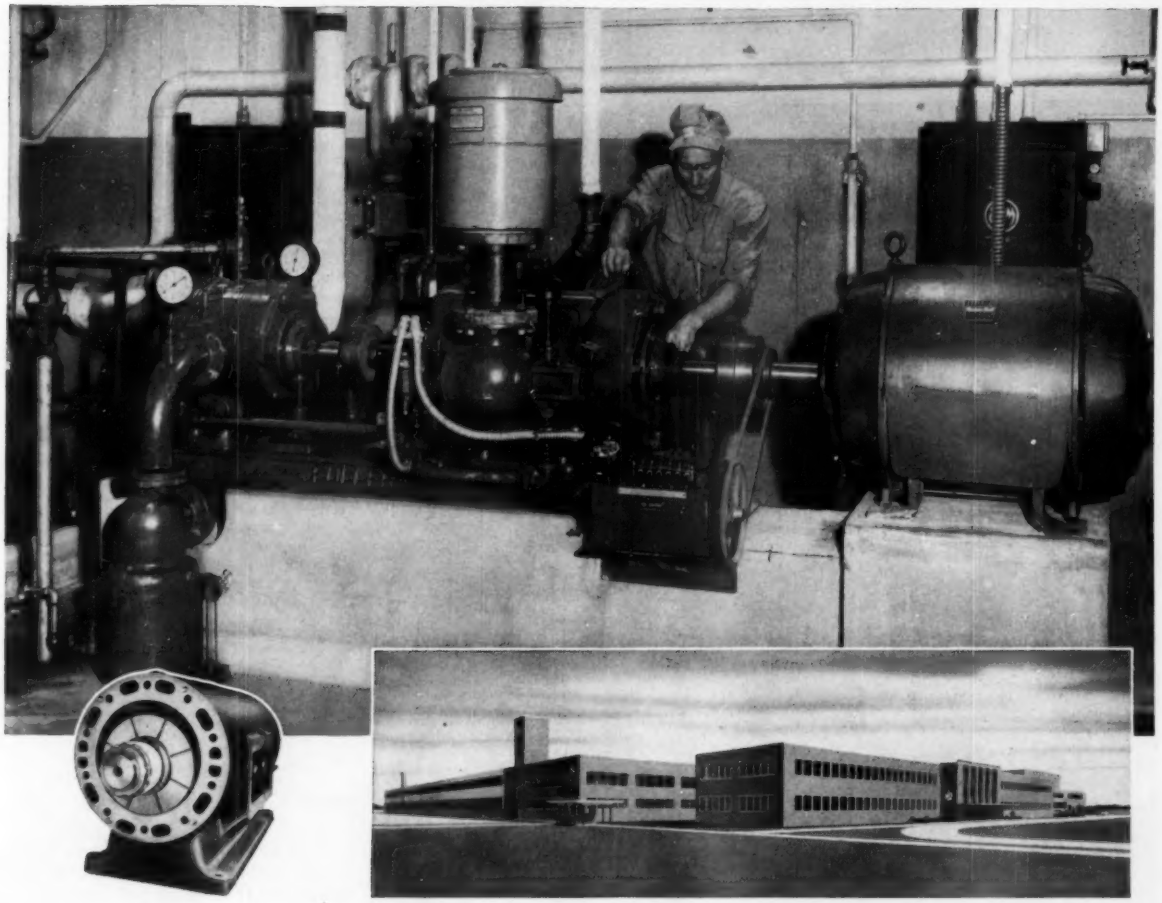
148 O-Ring Data — Engineering Handbook 525, 50-pp, features charts, illustrations, graphs and engineering data on development of the "O" ring seal design. Information on internal and external grooves, gland finishes, chamfers, selection of gland, piston rod, and cylinder materials and lubrication is included, as well as silicone rubber products, custom molding, decimal equivalents, temperature conversion table, circumference and area circles. Plastic and Rubber Products Co.

149 On Transite Pressure Pipe — How to install company's Transite pressure pipe for overhead industrial water and process lines is told in this 48-pp pocket-size guide. Text is divided into 15 sections and covers such items as hanging and supporting the pipe, bracing for thrusts, poured flange coupling and Roto-Split flange coupling. Suppliers of fittings, accessories and couplings are also listed, and diagrams of typical transite systems for overhead lines are included. Johns-Manville.

150 Drafting Procedure — This 56-pp booklet features standards on drafting room practice and simplified drafting. Results of a comparative test made by company between standard and simplified drafting practices are discussed and details on traditional and simplified procedures show how this company has put into practice simplified drafting as a "supplement" to standard practice. To expedite cross reference between specific items in the standard and simplified sections, similar numbers have been used for the corresponding paragraphs. American Machine & Foundry Co.

151 Welding Tips — Pocket Data Book (T IS 2575) features simplified welding procedures; covers 120 welding rods, electrodes and welding compounds. A guide to improved torch and metallic arc welding, brazing and soldering, it covers fabrication, maintenance repair and salvage, overlaying, and welding of dirty, rusted parts. Special applications such as joints with high electrical conductivity, resistance to chemicals, tinning and plating are treated. Weld preparation steps, ways to save dismantling, how to increase weld strengths are among other features. Also more than 60 low temperature welding alloys are listed. Available to qualified power engineers. Eutectic Welding Alloys Corp.

152 Lubricant Data Book — The 16-pp revised edition of company's popular Lubriplate Data Book offers practical information on lubrication of machinery. Gives product data on grease type and fluid products, hydraulic oil, compressor oil, motor oil. Suggestions on applying lubricants under normal and special conditions are provided. Several pages of book are devoted to lubricant recommendations for equipment used in a variety of industries, including chemical and food processing, metalworking, iron and steel plants, pulp and paper machinery, elevators, water and sewage disposal plants and others. Lubriplate Div., Fiske Bros. Refining Co.



Modern, reliable air power for a modern, efficient plant

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One of the items given serious consideration was the supply of compressed air, a considerable quantity of which is used throughout the plant. Fuller Company is justifiably proud to be associated with such a plant in being awarded the contract to furnish a Fullery Rotary Two-stage compressor as the main source of general plant air . . . a modern, efficient compressor for a modern, efficient plant. This machine has a capacity of 281 c.f.m., at 100-lb pressure.

Fuller Rotaries do a very big job no matter how tough the going. It's a job that, more and more, is being multiplied throughout all industry, these machines having gained wide acceptance as an efficient, reliable source of air power.

The key to Fuller's long life, and smoother operation, is *rotary motion*, which provides large capacity in relation to size, simple direct drive from motor or internal-combustion engine, minimum of working parts, air-flow free from pulsations, lack of vibration, continuous service with minimum supervision and maintenance. Installation in cramped quarters or on ordinary flooring is simple and practicable.

For a full description of Fuller Rotary Compressors and Vacuum Pumps, we would like to send you a copy of Bulletin C-5A. Write for your copy today.

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PIONEERS OF HIGH-EFFICIENCY VANE TYPE ROTARY COMPRESSORS SINCE 1930

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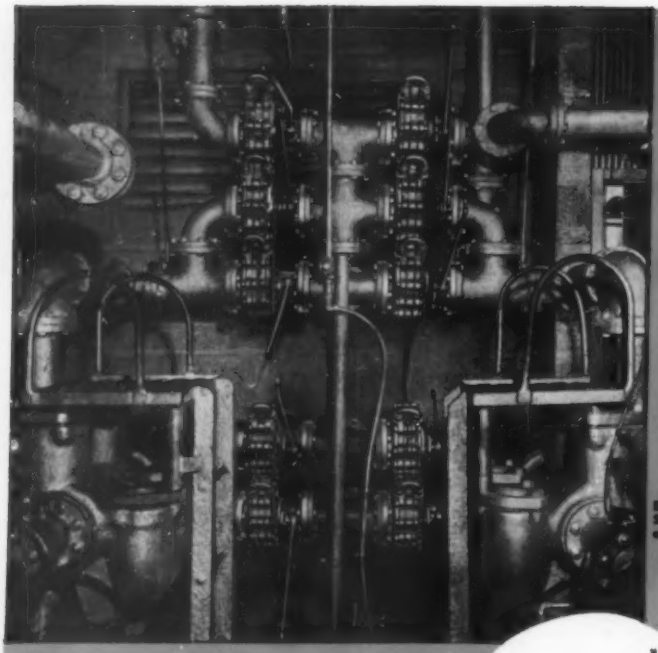
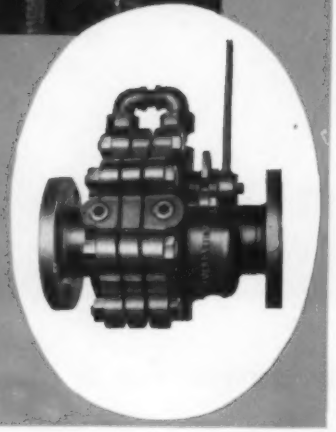


EVERLASTING Steam Jacketed Valves on manifolds handling hot products.

Jacketed Valves

that keep
Viscous Materials
flowing freely



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COOLING, AIR CONDITIONING

154 Sectional Heat Exchanger — Bulletin 132 illustrates and explains functions of the Sectional Aero heat exchanger. This self-contained system is designed to provide cooling of liquids in industrial plants independent of a large supply of cooling water and with additional savings of installation and operating expenses. Niagara Blower Co.

155 Improved Air Conditioning — This 12-pp booklet with flow charts in colors covers company's "staged cycle" and "closed reversing cycle" air conditioning methods and tells how they eliminate certain inefficiencies found in many air conditioning systems. Describes each principle and includes comparative power requirements, increased capacity data, photos of typical installations, diagrams and charts. A. I. McFarlan Co., Inc.

OTHER EQUIPMENT

156 Roller Chain — One of the most complete lines of roller chain and sprockets made is described in 148-pp Book 2457. It includes sections on stock drives, drive chain, conveyor chain, installation and maintenance, lubrication, sprocket wheels, casings and chain tighteners, among others. Profusely illustrated, book gives all information necessary to choose the right chain for a given application. Although not newly published, this book is a standard product guide and is again made available to qualified power engineers, who may not have known of it. Link-Belt Co.

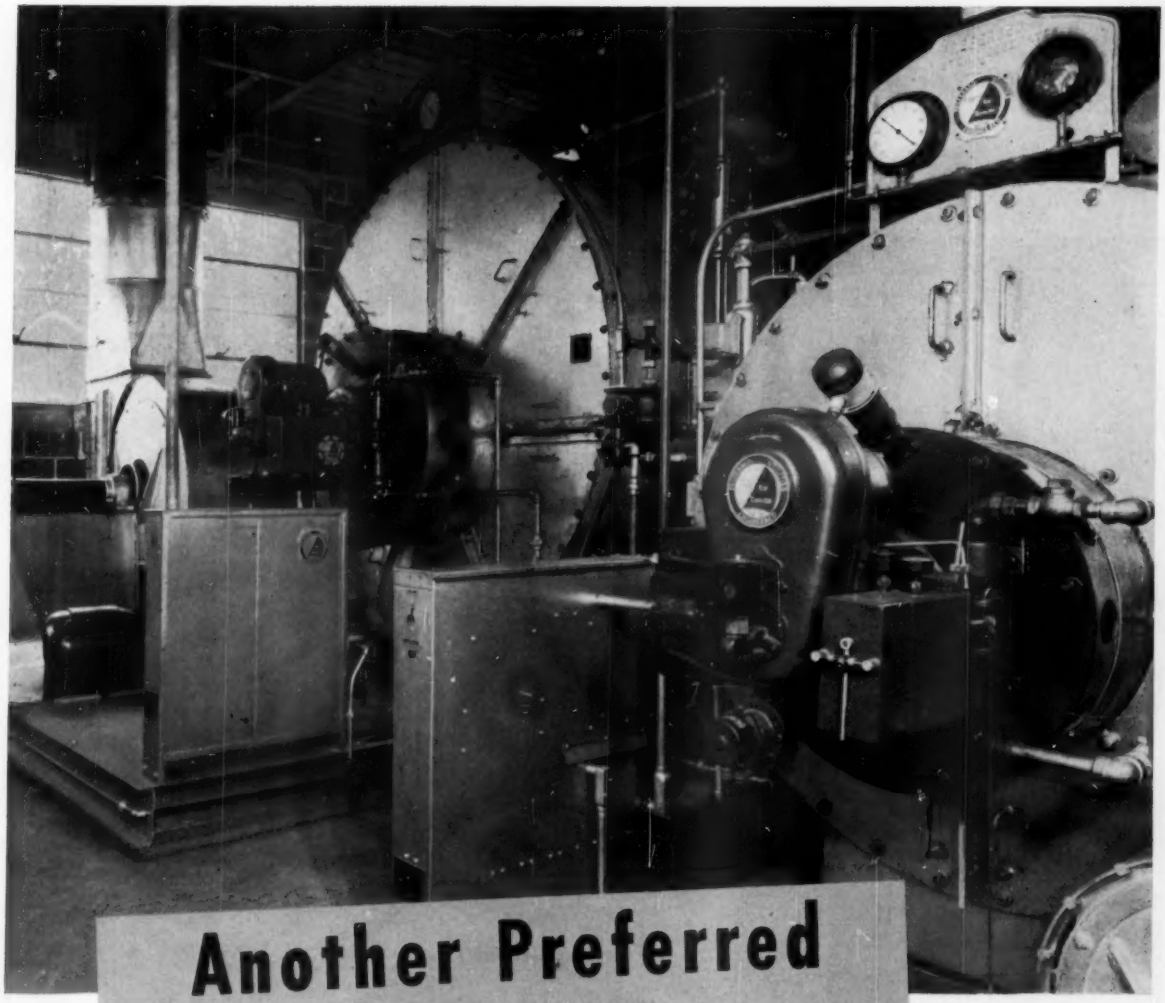
You'll save time in ordering bulletins by using the Reader Service Cards on page 125. Of course we honor letterhead requests—but it takes us somewhat longer to handle them.

157 Duct Insulation — Engineering data and application instructions for company's semi-rigid, spun mineral wool duct insulation are presented in this informative bulletin. Thermal and sound absorption characteristics are presented in tabular form and physical, chemical, mechanical and handling properties are described. Baldwin-Hill Co.

158 Boiler Family — Bulletin B-3300-A describes a wide range of company's heating and power boilers and includes photos and cutaway views showing construction features. A list of bulletins on the various types of boilers is included. Titusville Iron Works Div., Struthers Wells Corp.

159 On Teflon Products — Twelve-pp Form T-110 on John Crane products made from duPont Teflon, gives information on this material and applications for which it can be fabricated. Includes data on properties, specification table, and descriptions of products, together with operational and service data. Products described include packings; gaskets; bellows; sheet, rod, tubing and tape; molded and machined parts; electric, electronic parts and insulation. Crane Packing Co.

160 Centrifugal Dust Collector — Twelve-pp Bulletin 100 introduces the Cyclo-trell multiple tube dust collector which operates on centrifugal collection



Another Preferred Repeat User Reports

1953

Chandler Mfg. Co., East Taunton, Mass., makers of buckram and burlap, installed a Preferred 500 HP 125 psi. and a 70 HP, 15 psi. Unit Steam Generator.

1954

Mr. Paul T. McCusker, President, wrote, "I want to tell you how pleased we are with the performance of these two Units. In the past, I can't remember any maintenance that has cost us any down-time or any cash.

"We use a lot of process steam and we have saved a considerable amount of money on steam expense, in oil and in labor.

"One of the things we have been pleased about is the ease of operation of these units. Our men had no experience and yet, with a few hours instruction, they have run them for a year with no difficulty. The performance of these boilers is even better than I anticipated."

1956

Mr. McCusker added, "We are just as satisfied with our Preferred Units today as we were when we first installed them. In fact, due to our expansion we have just purchased another Preferred Steam Generator, 400 HP, to take care of the additional load, and it goes into operation in a few days. We are convinced we shall have an economical installation."

●

There are many more reports like this on Preferred installations in new boiler rooms, as expansions of steam demand and as replacements of less efficient boilers. Bulletin 2000 tells you why. Write for it.

PREFERRED UNIT STEAM GENERATORS

PREFERRED UTILITIES MANUFACTURING CORP.

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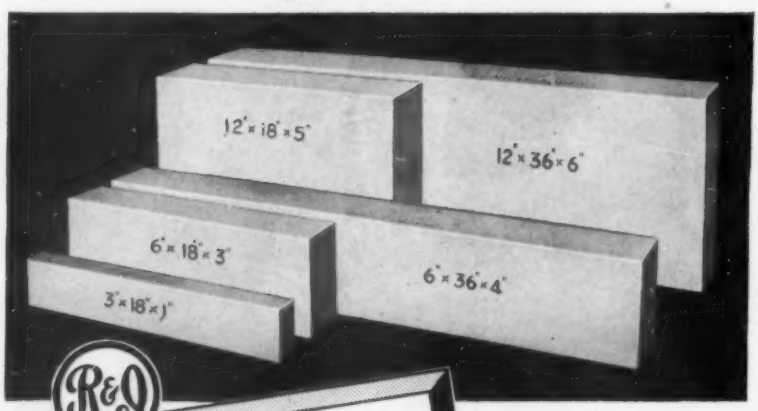

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principles and incorporates new features to boost collection efficiency and gas handling capacity. An illustrated explanation of operation and construction of this collector is accompanied by collection efficiency and capacity nomographs. Tables give design data for six sizes, from three to 20 tubes. Research-Cottrell, Inc.

161 Castable Refractories — Twenty-three grades of castable refractories are covered in this illustrated catalog, classified into five categories — super-duty, first-quality, intermediate duty, abrasion resistant, and insulating castables. Outlines advantages, charts characteristics, and lists typical applications. Plibrico Co.

162 Nickel, Nickel Alloys — Catalog 12, 20 pp, features brief handbook information on nickel and nickel alloys. Specific mechanical properties and chemical compositions of 13 analyses of nickel and nickel alloy tubing drawn at company's mill are tabulated, and selection and application data is included. Line drawings and photos illustrate the text. Superior Tube Co.

163 Tube Tools — Eight-pp Bulletin 58 describes advantages and application of company's line of tube cleaners, tube expanders and maintenance tools, including drills, brushes, accessory and specialty tools. Photos are included, as well as size and selection data. Airetool Mfg. Co.

164 Handy Data Chart — Now available to power engineers is an engineering data wall chart giving tables on decimal equivalents, temperature conversion, wire size and current ratings, and includes mechanical and electrical conversion tables. Chart is illustrated with photos of company's power supplies and a-c line regulators. Perkin Engineering Corp.

165 Shock, Vibration Control — Catalog SVC-55 discusses basic theory of vibration isolation and shock absorption. Covers various types of machinery vibration, gives basic data, formulae and graphs, and reviews practical methods of shock and vibration control. Industrial Div., T. R. Finn & Co., Inc.

166 Asbestos-Cement Sheet — This 6-pp folder, on Asbestocite, explains how this asbestos-cement sheet material can serve industry and shows typical applications — for cooling tower housings, cold storage room facings, construction of fume hoods and ducts, others. Gives information on physical properties, sizes, thicknesses and dimensional tolerances. Johns-Mansville.

167 Modern Process Heating — In 16 pp of photos and text, this catalog explains recent techniques in modern process heating, including a method of combining radiation with convection. Shows how these heating and conveyor systems offer safety, high output of energy, greater conservation of heat energy, controlled heat distribution, other benefits. Covers applications of booster ovens and complete systems. Jensen Specialties, Inc.

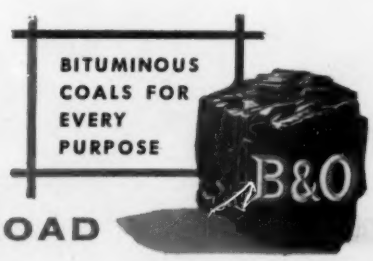
168 Steel Floor Armor — Uses of steel floor armor to prolong the life of floors are described in Form 503-955. Shows both application and installation of Hexsteel heavy duty floor armor and Floorsteel flexible type floor armor through simplified illustrations and engineering data. Includes detailed specifications for both products and instructions for determining proper size for a specific installation. Klemp Metal Grating Corp.

➔ Take a long look into the future. You'll see constantly growing industrial activity and millions of tons of *power-packed* Bituminous produced to sustain it, with *billions* still in reserve! B&O is a keystone to this vital supply and demand. The coal fields it serves hold proved, usable reserves of billions of tons of Bituminous for every purpose.

Today, tomorrow or decades ahead you may be sure that B&O Bituminous can be *your* best source of stable-low-cost power. It will pay you to use this *fuel with a future* NOW! *Ask our man!*

CONTACT OUR COAL TRAFFIC REPRESENTATIVE!

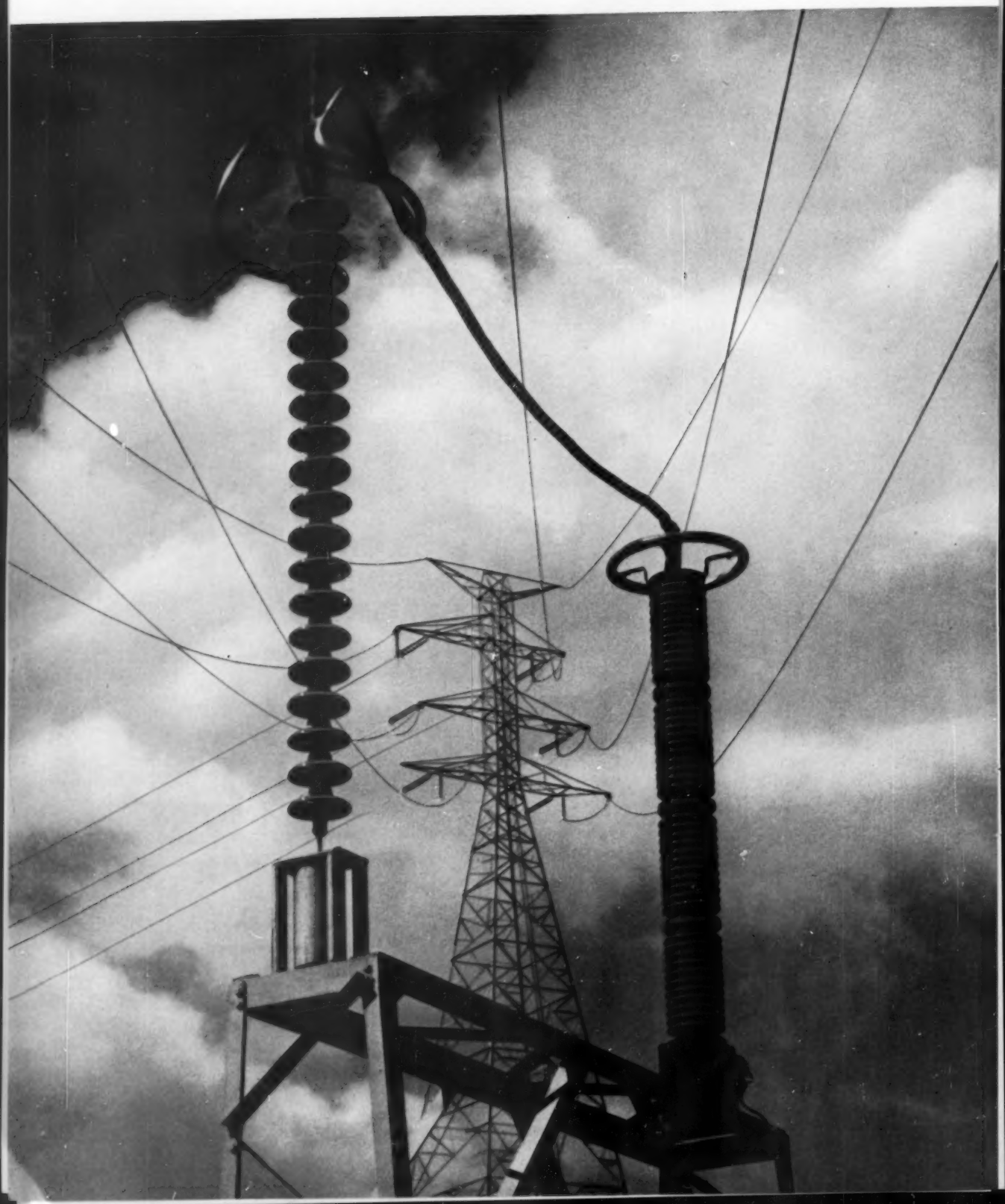
You'll receive details in the most efficient, low-cost Bituminous coal for your particular requirements.
COAL TRAFFIC DEPARTMENT B&O RAILROAD
Baltimore 1, Md. LExington 9-0400



BALTIMORE & OHIO RAILROAD

For more data circle 522 on Post Card

For the Mass



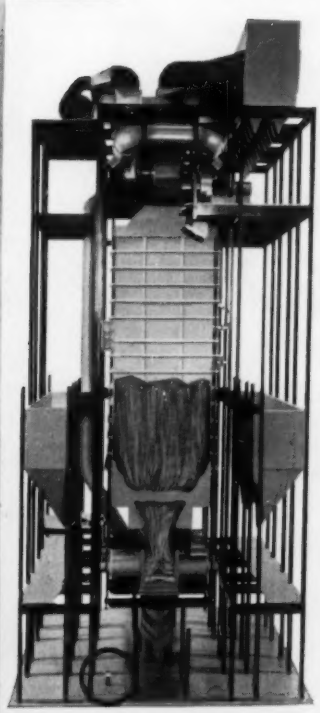
Production of Energy

"AMERICAN GAS AND ELECTRIC SYSTEM looks for a higher level of efficiency in the production of electric power than has ever been achieved before."

This firm prediction by Philip Sporn, president of the American Gas and Electric System, refers to the two largest steam-electric generating units in the world, which are to be added to the facilities of AGE.

Second and Third Universal Pressure Units for AGE

Each unit will produce 450,000 kw, enough power to supply the residential need for a city of 4,000,000 people—*more electricity than many complete utility systems.* Steam generators for the two units are of the B&W Universal Pressure type, and will be the second and third to go into commercial service .The first will start producing power at Ohio Power's Philo Plant in the near future.



Cyclone Furnace-fired B&W Universal Pressure Steam Generator to serve 450 MW turbine. Design pressure 4500 psi. Generates 2,900,000 pounds of steam per hour at 3625 psi, 1050 F. There are two stages of reheat to 1050 F. The second unit is similar in design but will be pulverized-coal-fired. Note comparison with six foot man standing at basement level.

Coal the Main Energy Source for Years Ahead

The decision to go ahead with these super-pressure, coal-fired units is based upon the fact that the bulk of our energy, for many years ahead, will come from coal, burned efficiently with economical equipment.

Two Firing Methods Utilized

Each of the B&W Universal Pressure Units will generate 2,900,000 lb of steam per hour. One will be Cyclone Furnace-fired and the other pulverized-coal-fired, to take greatest advantage of the method better suited to fuel and operating conditions in each case.

It takes courage and confidence in their engineering ability for AGE to initiate these world's largest generating units—and this confidence is reinforced by the work of the B&W organization and by previous experience with B&W research, engineering, manufacturing, field development and erection. These capabilities, skills and facilities are the real resources of B&W. For nearly 100 years they have been dedicated to serving the current and future steam-electric power needs of the nation.

The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

BABCOCK & WILCOX

BOILER DIVISION

C-812

Dairyland Power Cooperative, Wisc.
The Franklin Heating Station,
Rochester, Minn.
Kansas City Power and Light Co.
Missouri Public Service Co.
Montana-Dakota Utilities Co.
Pacific Gas & Electric Co.

Central Illinois Public Service Co.
Commonwealth Edison Company
Detroit Edison Co.
Jersey Central Power & Light Co.
Lake Road Station, Cleveland, Ohio
Pennsylvania Electric Co.
Public Service Electric and Gas Co. (N. J.)

NATIONWIDE!

East Side Station, Garland, Texas
Mohawk Station, Tulsa, Okla.
Salt River Power District, Ariz.
Texas Power & Light Co.
Tucson Gas, Electric Light & Power Co.
West Texas Utilities Co.

Carolina Power & Light Co.
Columbus & Southern Ohio Electric Co.
Georgia Power Company
Mississippi Power Company
Monongahela Power Company
South Carolina Public Service Authority

*Central Stations and Utilities use... Graver Deaerating Heaters**

A partial listing of tray and spray-tray type installations with capacities up to 2,250,000 lbs. per hour.

*WRITE FOR MANUAL OF POWER PLANT INFORMATION

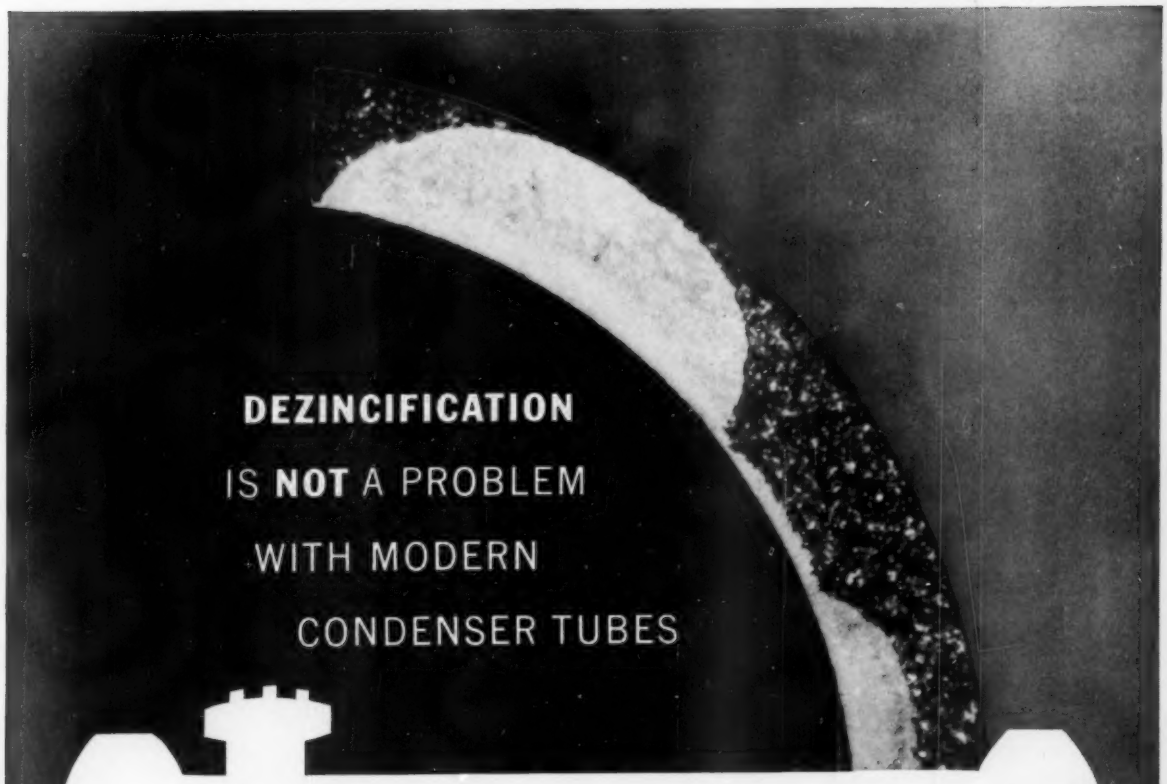
A COMPLETE LINE OF WATER TREATMENT EQUIPMENT

GRAVER

Industrial Dept.: I-212

GRAVER WATER CONDITIONING CO.
Division of Graver Tank & Mfg. Co., Inc.
216 West 14th Street, New York 11, N. Y.

For more data circle 524 on Post Card



DEZINCIFICATION IS **NOT** A PROBLEM WITH MODERN CONDENSER TUBES

Where *modern* condenser tubes are exposed to moist or wet conditions for prolonged periods, dezincification corrosion is not apt to occur. This is true even at high temperatures, which accelerate dezincification, and in water that is non-scale forming.

Use of the right tube alloy—one that contains arsenic or a similar inhibitor—retards dezincification. By preventing the loss of zinc and the redeposit of copper, there is little or no weakening of the mechanical strength of the tube.

FOR EXAMPLE: *The dezincification shown in the photograph would not likely have occurred if Arsenical Admiralty, Bridgeport Alloy #30, had been used. Where impingement corrosion is an additional factor, Arsenical Aluminum-Brass, Bridgeport Alloy #54, is recommended.*

When condenser tubes must be replaced—or new tubes specified—be sure you select a modern Bridgeport alloy that can "take it." Our Corrosion Laboratory will be glad to recommend the condenser tube alloy best for your operating conditions. Phone your nearest Bridgeport Sales Office today for prompt service on all your condenser tube needs.

For more detailed information on how modern condenser tubes resist corrosion, write today for your free copy of Booklet B-1.

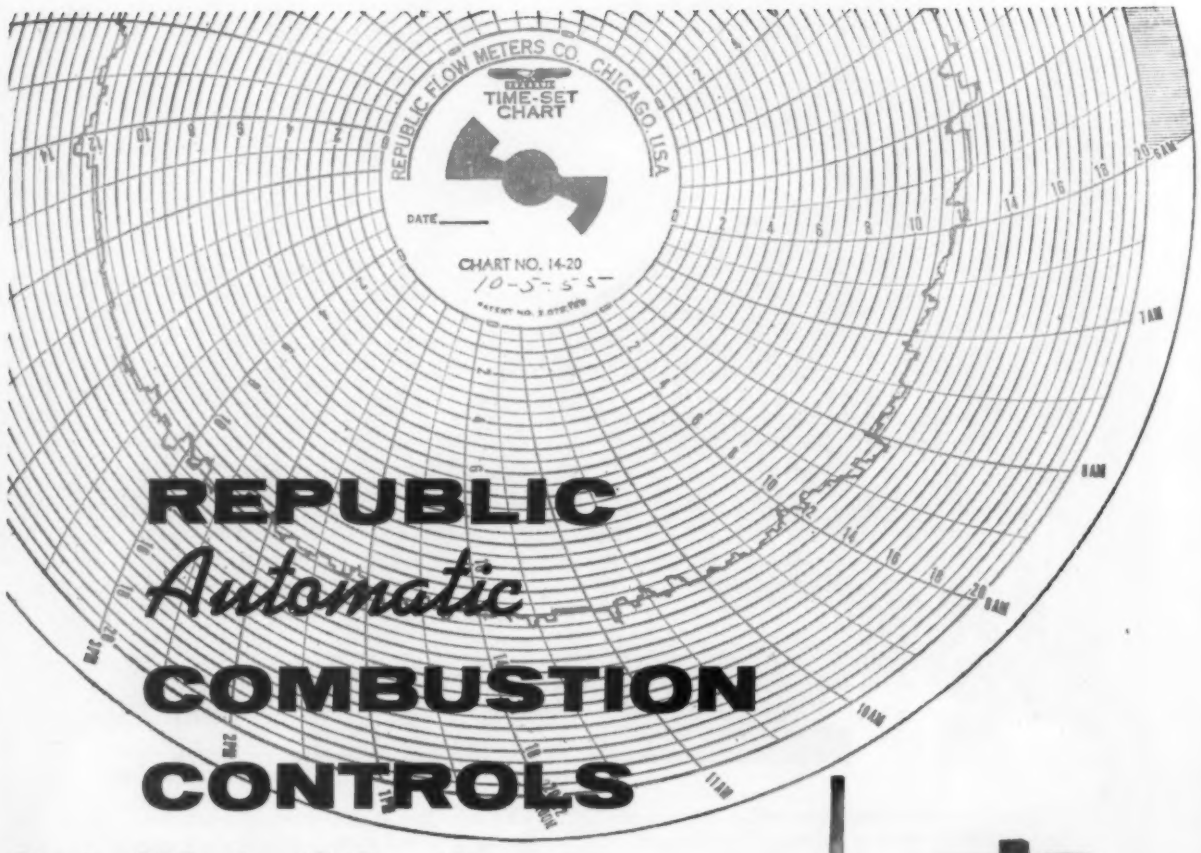
BRIDGEPORT CONDENSER TUBES

Bridgeport Brass Company, Bridgeport 2, Conn. • Offices in Principal Cities

In Canada: Noranda Copper and Brass, Limited, Montreal

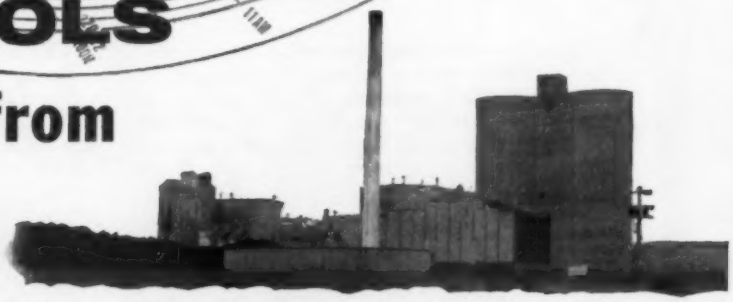
Photomicrograph of actual corroded condenser tube. Dezincification appears as white areas in tube wall.

For more data circle 525 on Post Card



REPUBLIC *Automatic* COMBUSTION CONTROLS

Get High CO_2 from Low Grade Coal



at UTAH-IDAHO SUGAR COMPANY'S NEW $7,000,000 PLANT

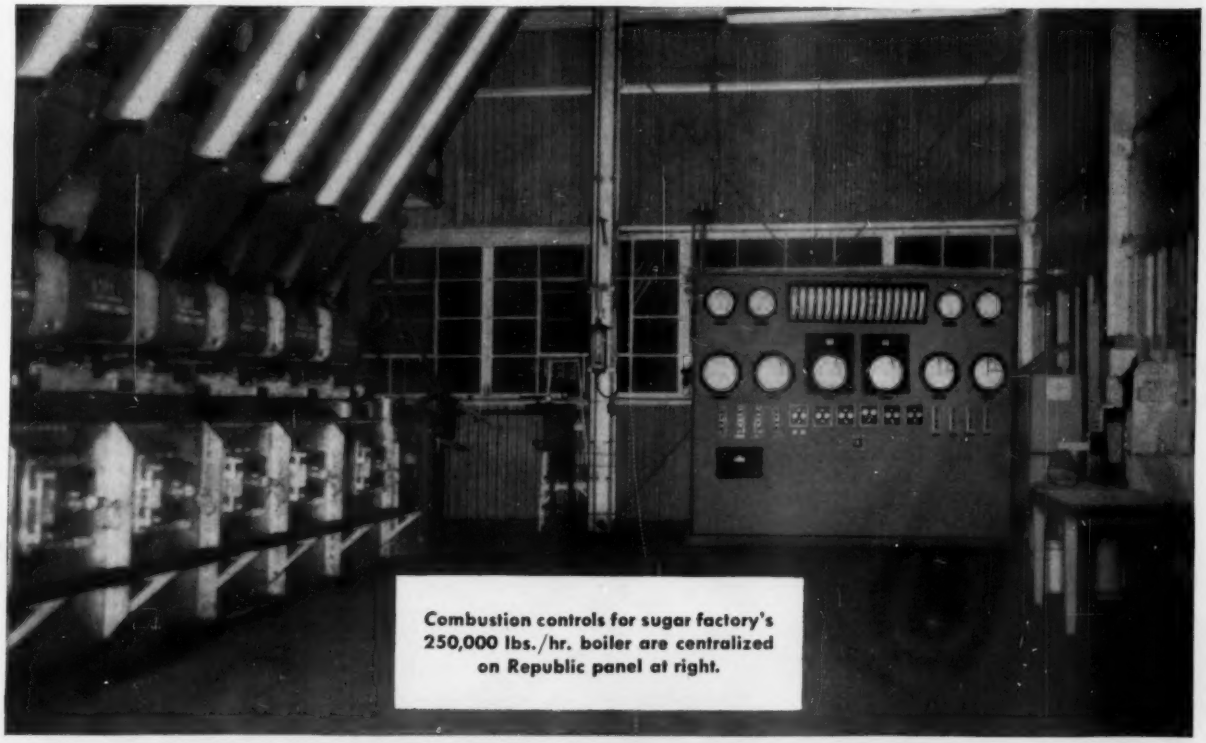
In any power plant, the percentage of CO_2 in combustion gases is indicative of combustion efficiency. But at the power plant for Utah-Idaho Sugar Company's new sugar beet factory, Moses Lake, Washington, a good CO_2 performance record is more than desirable. It's actually essential! That's because the plant supplies not only steam, but CO_2 as well to sugar-making processes. The CO_2 is extracted from combustion gases and becomes a vital ingredient in the production of over 75,000,000 lbs. of sugar and thousands of tons of molasses the factory produces annually. With the plant limited to low grade western coal, continuous maximum combustion efficiency at all loads is necessary to insure adequate CO_2 for processes.

Republic Automatic Combustion Controls enable the plant's spread stoker fired 250,000 lbs./hr. boiler

operating at 400 psig and 575°F. to meet CO_2 requirements while matching steam supply to process demands. Daily CO_2 charts indicate the boiler is consistently producing 12–13% CO_2 in spite of the quality of coal burned.

According to operators, ash removal, cleaning of the fire and soot blowing can be carried out with the combustion controls on automatic without disturbing the fuel-air ratio. Furnace draft is controlled satisfactorily despite the high stack on the plant. Turbine drives on forced and induced draft fans are speed controlled by the combustion controls, eliminating the need for dampers. A three element Republic boiler feedwater system is also tied in with the combustion control system to automatically supply the proper amount of water to the boiler at all steaming rates.

This plant is one more example of how Republic combustion engineers design control systems that enable boilers to exactly meet individual plant requirements. There are Republic Combustion Controls for any size or type of boiler, for all methods of fuel firing, all arrangements of draft and all load conditions. When you want to be sure of getting maximum boiler performance, ask Republic to design and build your combustion control system.



Combustion controls for sugar factory's 250,000 lbs./hr. boiler are centralized on Republic panel at right.

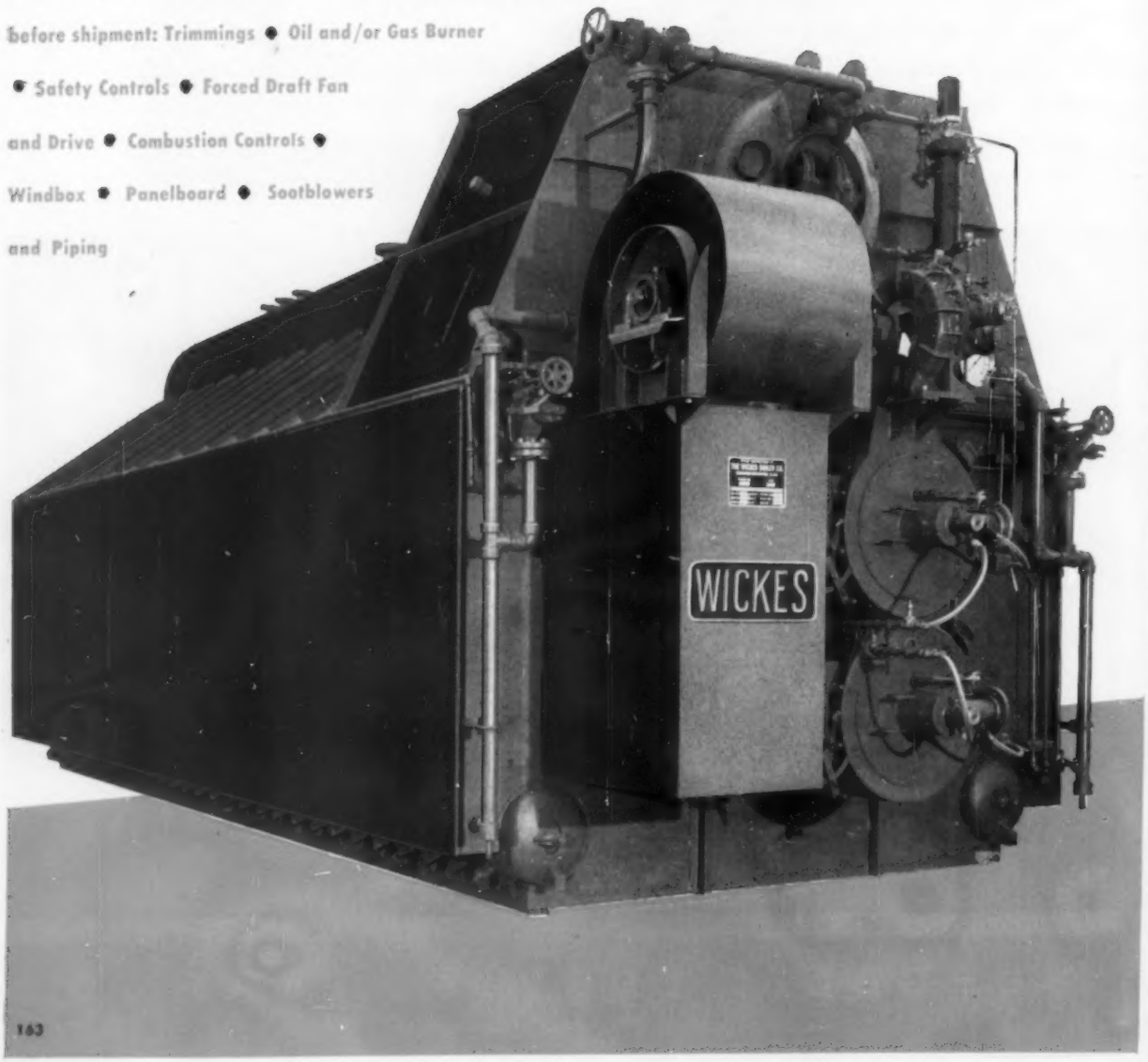
REPUBLIC FLOW METERS CO.
2240 Diversey Parkway, Chicago 47, Illinois

For more data circle 526 on Post Card

NOW!

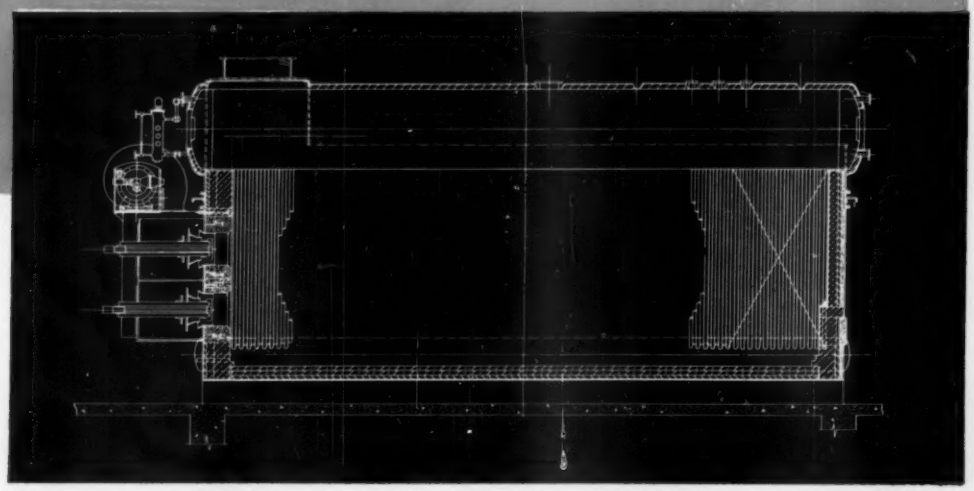
60,000 LBS. PER TYPE-A WATER TUBE by WICKES

Wickes Type-A Boilers include the following auxiliary equipment, installed before shipment: Trimmings • Oil and/or Gas Burner • Safety Controls • Forced Draft Fan and Drive • Combustion Controls • Windbox • Panelboard • Sootblowers and Piping



163

HOUR WITH A SHOP-ASSEMBLED STEAM GENERATOR



With capacities for sustained steam production up to 60,000 lbs. per hour the Wickes Type-A Boilers give you "packaged power" ready for immediate installation. They are custom engineered to your requirements and shop-assembled to reduce interruption of operations in your plant to a minimum. Wickes Type-A packaged boilers conserve head-room and floor space and are very simple in design . . . the large furnace is located between two banks of boiler tubes so that each furnace wall is a separate steam generator as well as an integral part of the boiler unit. The steam generator is enclosed in a high quality refractory and insulation setting and protected by a pressure-tight steel casing . . . thus, the pressurized furnace can be operated without a high stack or induced draft fan when burning oil or gas. This casing is also completely weatherproof for outdoor installation.

THE WICKES BOILER CO.

WICKES type A

Write for our Catalog 56-1 for detailed information on Wickes Type-A Boilers and we will also include our Bulletin 55-1 covering the complete line of Wickes Products and Facilities.

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

Recognized Quality Since 1854 • Sales Offices: Albuquerque, N. M. • Boston • Buffalo • Charlotte, N. C. • Chicago • Cleveland • Dallas Denver • Detroit • Fort Wayne, Ind. • Houston • Indianapolis • Los Angeles • Memphis • Milwaukee • New York City • Portland, Ore. Saginaw • Salt Lake City • San Francisco • Springfield, Ill. • Tulsa • Washington, D. C.

For more data circle 527 on Post Card

ECON'S exclusive STOP-WATCH ACTION MAKES THE BIG DIFFERENCE

When current overload is continued beyond the safe and pre-determined time, exclusive Econ-Alloy breaks the circuit by changing directly from solid to liquid. The usual plastic stage is eliminated, insuring faster, more accurate protection against overloads and shorts . . .
ECON-ALLOY makes the DIFFERENCE
• Stops needless fuse blows safely
• Complete protection against shorts and dangerous overloads
• Cuts fuse costs and downtime

You protect against needless fuse blows yet get faster, more accurate protection against shorts and dangerous overloads when you use ECON Dual-Element Fuses. The exclusively different breakaway action of the ECON-Alloy element gives you this important advantage.

ECON®
DUAL-ELEMENT cartridge fuses

The ECON-Alloy thermo element has a double stop-watch action. First, it acts instantly on shorts. Second, with its pre-determined delayed timing, it safely handles overloads—up to 500%—without blowing.

Available in knife and ferrule types: 0 to 600 amperes; 250 and 600 volts. Underwriters' Laboratories Inc., approved.

Write for ECON Dual-Element Catalog S-60...
or complete line folder on all Economy Fuses

ECONOMY FUSES FOR EVERY PURPOSE

1458

Ask your ELECTRICAL WHOLESALER for ECON Dual-Element and other Economy Fuses.

ECONOMY FUSE & MFG. CO., 2717 Greenview Avenue, Chicago 14, Illinois

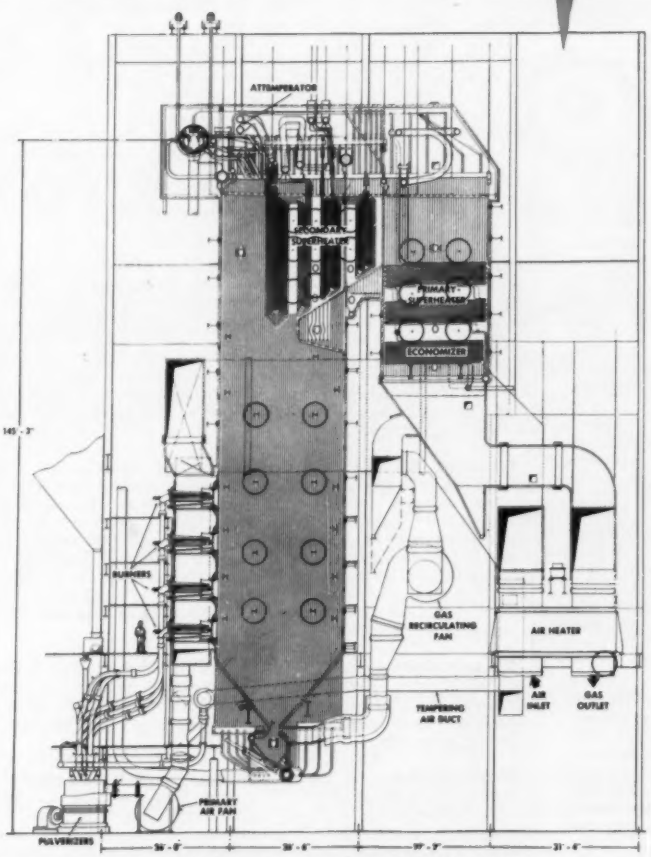
For more data circle 528 on Post Card

It's Vulcan Selective Sequence for Astoria Station's 2,400,000 lb./hr. Boiler!

Each of the two forty-foot furnaces firing Consolidated Edison's Boiler 30 at Astoria Generating Station will be equipped with a custom-designed Vulcan Selective-Sequence Soot Blowing System. The boiler now being built by Babcock & Wilcox is a radiant-reheat type to be fired by pulverized coal, oil or gas.

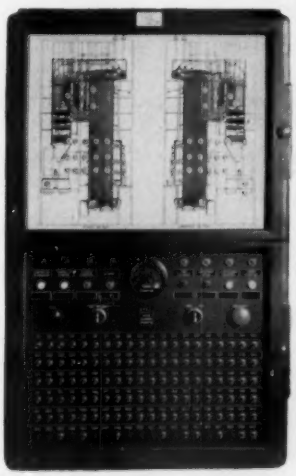
Drive for the soot blower systems will be electric; the blowing medium steam. Both Vulcan long retractable soot blowers and wall deslaggers are included in the system. Vulcan wall deslaggers maintain high striking power, keep thickness of deposits to a minimum.

Whether your boiler is large or small, power or process—a modern Vulcan Soot Blower System with automatic-sequential or selective-sequence control will keep it operating at peak efficiency. Your Copes-Vulcan representative has the ideas, information and experience to help you choose the system best suited to your needs.



CONSOLIDATED EDISON COMPANY
ASTORIA GENERATING STATION, NEW YORK, NEW YORK
BABCOCK & WILCOX TWIN-FURNACE BOILER
2—40'—0" FURNACES

Capacity, Lb. Steam per Hour 2,400,000	Superheater Outlet Pressure, PSI..2,150
Design Pressure, PSI..... 2,500	High Pressure Steam Temp., F....1,050
Reheat Steam Temperature, F....1,000	



NERVE CENTER of the Selective-Sequence system is a completely pre-wired, factory-assembled controller for the soot blowers in each furnace. Selective Sequence lets operating personnel select proper blowing sequence for most effective boiler cleaning. Operator can tell at a glance which blowers are operating, time elapsed, number of blowers that have operated, and any malfunction of equipment or blowing medium.

B-7637A

COPES-VULCAN DIVISION
BLAW-KNOX COMPANY
ERIE 4, PENNSYLVANIA

50th Anniversary BLAW-KNOX 1906-1956

For more data circle 529 on Post Card

CONSTRUCTION NEWS

Pine Bluff, Ark. — The International Paper Co., 220 E. 42nd St., New York, N. Y., plans steam power house at new plant for the manufacture of paper products, at Pine Bluff near Johnson Lake. New plant will comprise a group of one and multi-story buildings, including mill management and administration offices. Preparatory work on ground clearing and foundations is already under way and plant is expected to be in partial production by late 1957. Cost when completed is reported to be in excess of $57,000,000. Plant will have an annual capacity of 130,000 tons of newsprint and 165,000 tons of bleached kraft paper board when in full operation.

Jacksonville, Fla. — The City of Jacksonville, Fla., has arranged for financing in the amount of $14,000,000, to cover cost of public utility construction and improvements in municipal power plant. Portion of fund will be used in connection with current expansion and improvement program, covering power plants, transmission lines and other miscellaneous operating facilities.

Jacksonville, Fla. — The National Container Corp., 7 Central Park West, New York, N. Y., has plans under way for expansion of power house and facilities in conjunction with kraft pulp and board mill addition to local plant here. Site of 100-acres on the St. John's river adjoining present mill has been secured for the purpose and work will begin at once. Plant addition will represent an investment in excess of $25,000,000.

Bay City, Mich. — The Consumers Power Co., Jackson, Mich., has work under way on the installation of a new power plant with a capacity of 240,000-kw at the mouth of the Saginaw River, Bay City, Mich. Cost of initial installation reported to be about $9,800,000. Other installations are planned for the future to ultimately bring generating capacity at new location to 1,700,000-kw, which is more than present capacity of entire system. Townsend & Bottom, Inc., 2245 State St., Ann Arbor, Mich., are consulting engineers.

St. Paul, Minn. — The Northern States Power Co. (Minnesota), 15 S. Fifth St., Minneapolis, Minn., has authorized plans for major addition to company's High Bridge plant in St. Paul, Minn. New steam-electric generating unit with an initial capacity of 150,000-kw will be installed at a cost of $24,000,000, and when completed in 1959 will be the largest generating unit in the midwest. When in operation in 1959, new unit will increase plant capacity to more than 450,000-kw.

St. Louis, Mo. — The Union Electric Company of Missouri has asked the Securities and Exchange Commission to grant permission for the sale of a $40,000,000 bond issue proceeds of which will retire short-term bank loans, finance additions and improvements to generating stations and equipment and for other corporate purposes. Company's budget for 1956, approximates $42,000,000 for current construction program, including large increase in generating facilities, transmission lines, power substations and other miscellaneous work.

Manchester, N. H. — The Public Service Company of New Hampshire, 1087 Elm St., has arranged sale of bond issue in the amount of $8,000,000, proceeds to be used to pay off short term construction loans incurred in connection with expansion and improvements program in plants and system, including improvements in generating facilities, power substations, transmission lines and other work.

Asbury Park, N. J. — The Jersey Central Power & Light Co., 501 Grand Ave., is arranging sale of bond issue in the amount of $10,000,000, proceeds to be used to pay off short term bank loans of $3,750,000 and the remaining $6,250,000 for new expansion and improvement of company facilities. The company's 1956 budget for construction and improvements is estimated at $14,650,000.

Massena, N. Y. — The Reynolds Metals Co., Reynolds Metals Bldg., Richmond, Va., has plans under consideration for the construction of a new aluminum fabricating plant for the manufacture of aluminum components for the automobile industry near here, providing power negotiations now under way with the New York State Power Authority can be worked out to give aluminum concern the power necessary from the authority's Niagara River plants. Negotiations are still in progress with final arrangements to be announced at a future date.

New York, N. Y. — The American Gas & Electric Co., 30 Church St., New York, N. Y., and the Commonwealth Edison Co., 72 W. Adams St., Chicago, Ill., have plans under consideration for the erection of a 330,000-volt transmission line, approximately 90 miles in length, for the interchange of large blocks of emergency power between the two systems in the event of a breakdown of major generating or transmission facilities or during periods of peak loads. New line will be constructed between a terminal of the Indiana & Michigan Electric Co., New Carlisle, Ind., and a new distribution center Commonwealth Edison will build at Goodings Grove, Ill. The extra high voltage wire will be placed in operation by mid-1958 at a cost of $25,000,000.

Avon Lake, Ohio — The B. F. Goodrich Chemical Co., 2069 E. 9th St., Cleveland, Ohio, has announced an expansion program of major proportion at company's facilities here. Expansion program will include a new large boiler plant and will double production capacity of polyvinyl resins and plastic compounds. The Girdler Company, Division of the National Cylinder Gas Co. has been awarded the contract for the work which is now under way. Cost reported to be $8,000,000.

Piqua, Ohio — The Pioneer Rural Electric Cooperative, 202 N. Downing St., has work under way on expansion of generating plant at local site here. New installation of generating equipment will be made adjacent to present municipal power plant and is expected to be in operation in the early part of 1957. New installation reported to cost $3,500,000.

Oklahoma City, Okla. — The Oklahoma Gas & Electric Co., 321 N. Harvey St., Oklahoma City, Okla., has authorized construction of a new steam-electric turbine generator for delivery in mid-1958, at an estimated cost of $4,000,000. Location of new unit with an initial capacity of 150,000-kw has not as yet been decided and when in operation will supply the needs of an area twice the size of Oklahoma City. The turbine will be built at Westinghouse Electric Corporation's steam division plant in South Philadelphia and the generator at the east Pittsburgh plant of Westinghouse.

Portland, Ore. — The Portland General Electric Co., 610 S.W. Broadway, has filed with the State of Oregon, for a license to construct the North Fork-Farraday hydroelectric developments on the Clackamas River, just outside of Portland, Ore. If application is approved, company plans to have 78,000-kw project completed and in operation by December 1958, at a total cost of $19,000,000. Portland General Electric Co. applied for a license last fall from the Federal Power Commission to build the North Project only. Cost of this phase of the project alone was estimated in excess of $13,000,000.

Moncks Corner, S. C. — The South Carolina Electric & Gas Co., 328 Main St., Columbia, S. C., has plans under way for new steam-electric generating station at local site. No information regarding size of installation available at this date. Project is reported to be estimated at $50,000,000.

Mission, Tex. — The Central Power & Light Co., 120 N. Chaparal St., Corpus Christi, Tex., has plans under way for new electric power plant on 5-acre tract of land recently acquired for the purpose. Work will include installation of new turbine generator, high pressure boiler and auxiliary equipment. Cost of plant including some transmission lines, reported to be in excess of $7,000,000. Proposed to begin work soon.

Port Arthur, Tex. — The Texas Co., Chrysler Towers, New York, N. Y., has announced plans for the construction of a new power generating station at plant facilities here. Steam and electric generating capacity will include installation of 3,300,000 lb. per hour steam generators, and one 15,000-kw electric generator with auxiliary installations. Contract in the amount of $6,575,000 has been awarded to Jackson and Moreland, 600 Park Square Building, Boston, Mass., engineers.

Roanoke, Va. — The Appalachian Electric Power Co., a subsidiary of the American Gas & Electric Co., 30 Church St., New York, N. Y., has plans under consideration for the erection of a 60,000-kw hydroelectric generating station at Smith Mountain Gap on the Roanoke River in Virginia. New plant is projected for the future and construction will get under way within the next year or two. Project is estimated to cost in excess of $20,000,000. Application to the Federal Power Commission for a preliminary permit has been filed and completion of preliminary explorations of the dam-site and arrangements for the disposition of roads affected by the reservoir are under way.

A Diamond Policy for Decades:

"Keep It Basic" . "Avoid Unnecessary Complications"

For Example . . . SINGLE MOTOR DRIVE on DIAMOND Model IK Long Retracting Blowers

A Single Motor (air or electric) Both Rotates and Propels the Long Lance Tube

Diamond engineers have always felt that it isn't enough to design a mechanism that will do a particular job. It is also important to make that mechanism as simple and dependable as possible. It has been a Diamond policy for decades to *"keep it basic"* . . . to avoid unnecessary complications that make trouble for users.

Diamond Soot Blowers are simple, effective, dependable. Typical of this is the single motor drive on the Model IK Long Retracting Blower. One motor working through a simple system of rugged gears simultaneously propels the carriage and rotates the lance tube. The ultimate in simplicity and reliability, there is only one set of motor elements, one set of control elements, and one set of power supply facilities to operate and maintain. Long experience with all kinds of cleaning problems has demonstrated conclusively that there is a single universal cleaning pattern suited to substantially all conditions encountered.

Other important features of Model IK are the mechanically operated valve with adjustable pressure control, and the positive gear drive. For additional information ask for Bulletin 1080 AB.

DIAMOND POWER SPECIALTY CORPORATION

LANCASTER, OHIO

Diamond Specialty Limited • Windsor, Ontario

Diamond

7466

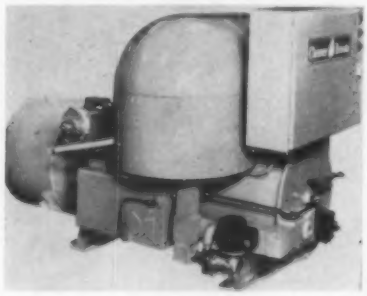
For more data circle 530 on Post Card

EQUIPMENT NEWS

Described on these pages are new and improved products. Use Reader Service Cards on pages 125–126 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

1—GUN-TYPE BURNER designed to burn No. 6 fuel oil

This 90-gph burner introduces a new method of burning residual oils. Air and oil are metered in proper ratio at all capacities to assure maximum efficiency, company explains, and oil is finely atomized so that it burns easily and



completely. A positive acting metering pump delivers the oil. Once the burner is set for the most efficient combustion it remains at that point. According to manufacturer, this burner does not start at full capacity but begins with a small flame which is gradually built up to the required size. The shape of the flame is adjusted for the type of boiler the burner is to be used with. Combustion controls are standard equipment. Cleaver-Brooks Co.

2—ELECTRIC GOVERNOR for engine generator sets

For precise speed regulation of engine generator sets, this electric governor is designed to anticipate speed change by constant load sensing while regulating on the generator frequency. Manufacturer explains that "brain" and "muscle," practically instantaneous electrical circuitry and a responsive, high-force hydraulic system act together to initiate actual throttle change in about 0.015 sec after a change in electrical load. Performance data are reported to show transient speed (frequency) deviations less than 1.5 per cent for full load change, and recovery to steady state in less than 1 sec. Under steady conditions, the governor is said to control generator output frequency within ±0.25 per cent of base frequency.

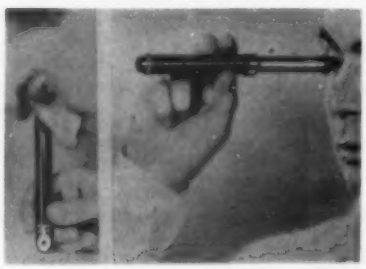
This governor is also reported to enable parallel operation of two or more engine generator sets, with all units adjusted for zero speed regulation. Thus adjusted, the governors provide automatic load sharing between units. For parallel operation with units equipped with conventional governors a speed regulation control is provided. Three basic units form the system: an electrical control unit which senses output frequency, electrical load and throttle position and which integrates these quantities into a single signal; an hydromechanical actuator which converts this signal into mechanical force to position the engine throttle according to requirements; and a simple hydraulic power supply. Driven by the governor power take-off, this unit supplies hydraulic fluid under pressure to the actuator unit. Westinghouse Electric Corp.

3—PRESSURE TRANSMITTER is low cost, lightweight unit

Operating on the force-balance principle, the Model P Pressure Transmitter is described as lightweight, rugged, yet sensitive unit. It is suggested for services involving viscous substances, or materials which solidify in the static lines of bourdon tubes. It also has application for liquid level indication on open tanks containing viscous materials or those with solids in suspension. According to manufacturer, the Model P is unique in that it utilizes simple, flat diaphragms instead of bellows, and this eliminates possibility of viscous materials hardening in bellows convolutions. Diaphragm material is rubber, Teflon, or stainless steel, depending on temperature range and corrosiveness of service. The pilot is isolated from the pressure diaphragm so that controlled gas or liquid cannot back up into air lines in event of diaphragm failure. Bulletin P-2520-2 gives more information. Conoflow Corp.

4—MICROSCOPE-TELESCOPE is the size of a fountain pen

Power engineers will find dozens of uses for this handy pocket instrument, combining a 50 power microscope and a 10 power telescope. Approximating a foun-



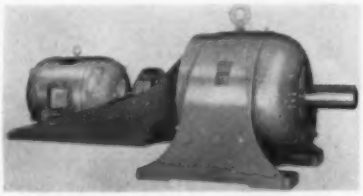
tain pen in size, when used as a microscope it will enlarge 50 times. Ideal for close-up examinations of small parts, for spotting, checking, inspecting on machining operations. You just tilt it to focus, and a metal reflector throws light on the object. When used as a telescope, you simply unscrew metal reflector, draw out eyepiece tube and sight. It brings distant object ten times closer for chimney, roof, wire inspections, and distant gage readings. Instrument is equipped with a clip to hold in coat pocket, finished in chrome and black, and sells for approximately $4.50. Edmund Scientific Corp.

5—FISH TAPE WINDER protects hands, saves tape

Easier, faster, safer wire pulling and less tape breakage are advantages claimed for the Tape-Mate. It fits completely around the reel and is assembled with four screws. Once in place, it stays on permanently, says manufacturer, and will last as long as the reel. Anyone can use the Tape-Mate, for it simply slides around the reel. When holding reel in usual manner, winder is pushed forward to wind — or pulled back to pay out tape. The hand never has to touch the tape. It is claimed that tape can be payed out to exact footage needed with springing eliminated by keeper slot. When winding, tape can be put back in perfect shape as fast as it is pulled from conduit. Uniform tension is produced by a cam pressing against tape. Finger grip design prevents hand from slipping and gives good grip for pulling. The handy fish tape winder fits all 12-in. fish tape reels containing ¼ in. flat fish tape, and sells for about $2.75. Holub Industries, Inc.

6—MOTORIZED REDUCER with special motor support

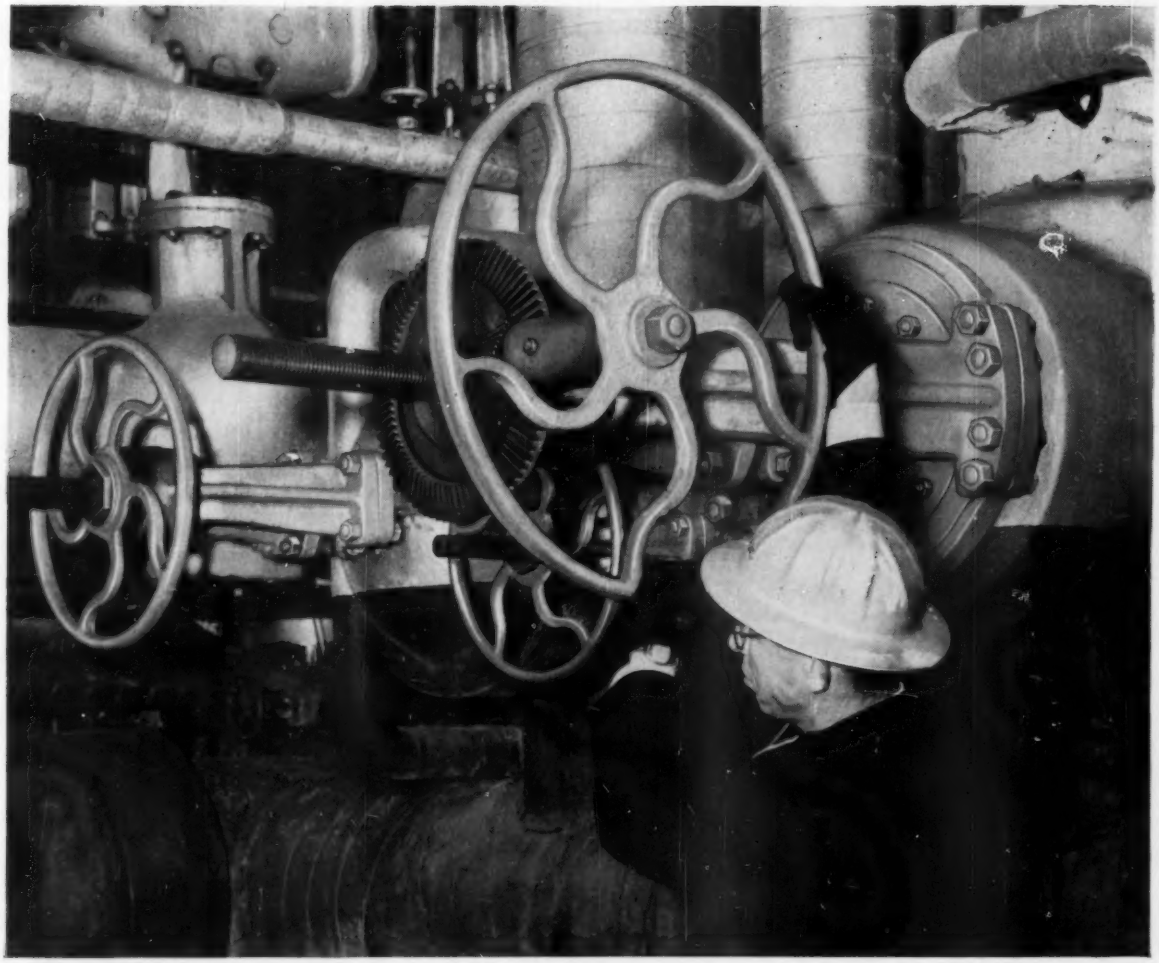
The Line-O-Motor is designed to combine advantages of integral motor-reducer units with the versatility of



separately mounted motors. Reducers are equipped with a specially designed motor support bracket — reducer base supports both reducer and motor for easy set-up and shaft alignment. Motor mounting bracket slots are standardized to suit all NEMA motors. Line-O-Motor is available in horizontal models for foot mounting or in vertical and vertical extended housing models for flange mounting. Its capacity ranges from 1 to 75 hp for any A.G.M.A. service classification. Double, triple or quadruple reductions provide ratios from 5.06:1 to 238:1. With Line-O-Motor drives, smaller stocks of standard motors are declared practical, motor change faster and drive systems more versatile. Foote Bros. Gear and Machine Corp.

7—SOLID FILM LUBRICANT comes in aerosol bomb

When sprayed on troublesome parts, (both metallic and non-metallic) Lubri-Bond A is said to increase the wear-life by decreasing the coefficient of friction of these parts. The resin-based, air-dry lubricant is reported to operate in a



12 years' cost-free service completed by this Crane valve on saturated steam

Since 1944, this Crane 16-inch Pressure-Seal gate valve has been handling 450 psi saturated steam. It's working as a stop valve on a header in the Neches Butane Products Company's butadiene plant in Texas.

When opened for inspection recently—after 12 years of hard service—this rugged Crane valve was found to be in perfect condition. Not once has it leaked or needed maintenance at the bonnet joint or seat.

Here's why: instead of depending on bolting to retain pressure, the Crane Pressure-Seal bonnet design utilizes internal fluid pressure to make a leak-free, maintenance-free joint. And with the Crane flexible wedge disc—self-adjusting to temperature changes—sticking of the disc is eliminated, and operation is always smooth and easy.

Because they're so trouble-free, and so compact and streamlined (saving line weight and simplifying insulation), Crane Pressure-Seal Bonnet Valves are giving consistent satisfaction on high-pressure, high-temperature power plant service. Get full information from your local Crane Representative, or write to address below.

CRANE VALVES & FITTINGS

PIPE • KITCHENS • PLUMBING • HEATING

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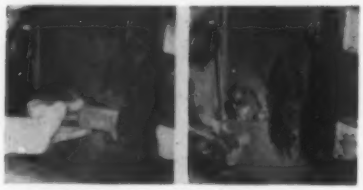
temperature range from −300 to 500 F, and to be an excellent choice for parts operating at high speed and high load. Lubri-Bond A dries in 30 min and can be used in conjunction with oils and greases where oil is necessary as a cooling agent, according to manufacturer, or it can be used without them. It is suggested for gears, actuators, cams, hinges, pins, shafts, tracks, threaded parts, frictional bearings, and other moving surfaces where friction is a problem. It comes in convenient 12-oz spray bomb containers. Electrofilm, Inc.

8—VACUUM SWITCH for single-bank capacitor equipment

A low cost method of switching single-bank capacitor equipment is made possible with Type IV Vacuum Switch, it is announced. Except for a vacuum interrupting chamber, switch is similar to conventional three-pole, group-operated air break switch. However, it provides switching service only, not fault interruption. The vacuum switch is available with all single-bank, grounded capacitor installations between 7.5 and 115 kv, and with ungrounded banks between 7.5 and 69 kv. Switch is rated 600 amp continuous current, with a 4 sec symmetrical rating of 25,000 amp. The momentary current asymmetrical rating is 40,000 amp and recommended maintenance period is after 2,500 operations. General Electric Co.

9—REPAIR PROCESS for castings, now in kit form

The Chain-Lock method for cold repair of cracked or broken castings is now available in kit form, so that repairs can be made by anyone equipped with the kit. In it are all tools, equipment and instructions necessary to repair engine blocks, cylinder-valve ports, housings, other castings. In use for many years, the process formerly was available only from licensed shops. Repairs made by it are claimed water and pressure tight, resistant to extremes in temperature



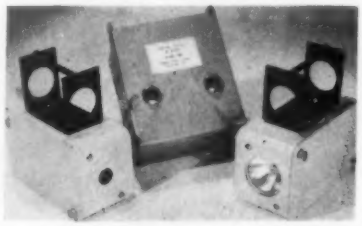
and the strains of expansion and contraction. Company says that such repairs meet insurance approval and requirements of service inspections. Repairs are made without heating, welding or brazing. It is explained that the Chain-Lock method binds and locks the two sides of the crack or break together, then seals it. Chain-Lock Process Co.

10—BEARING TOOLS have retaining spring finger

This line of less expensive bearing assembly and bearing handling tools is equipped with a retaining spring finger to lightly grip either the inside bore of the bearing or the outside diameter. Tools are available in either male or female types to insert bearings into a housing bore or over a shaft, and pressure surfaces of tools prevent forces being applied through the balls and races with consequent damage to precision bearings. The tools are not intended to be used as pullers but are useful for assembly. The Baker Co., Inc.

11—SMOKE ALARM is positive detection system

Smok-Trol 85 is announced as an inexpensive, simple, yet positive system for detection of smoke in power plants, heating systems or anywhere smoke means waste or nuisance. It is used in conjunction with audible or usual alarm



systems, instantly alerting operator to unsatisfactory combustion conditions. Instrument is of plug-in design for easy replacement of tubes, and employs a cadmium sulphide cell for light detection. Smok-Trol Corp.

12—HYDRAULIC FLUID is fire resistant type

Irus Fluid 902 is announced as an economical "snuffer" type hydraulic fluid with fire-resistant qualities that prevent its burning on contact with flames, heated metal surfaces or molten metal. A formulation of water, petroleum, hydraulic oil and emulsifying agents, the fluid eliminates possibility of combustion by releasing its water content as a protective steam blanket to quench fire, manufacturer explains. This "snuffer" action reduces local temperatures and displaces oxygen from the immediate area — it is noted that in most cases the remainder of the hydraulic fluid will not support its own combustion. Another advantage cited is that the oil will continue hydraulic action should the water be dissipated.

Despite the water in its composition, the fluid is said to possess all petroleum oil characteristics vital to proper functioning of hydraulically-operated machinery. It is reported noncorrosive on ferrous and most non-ferrous metals; compatible with normal system components; as having film strength and high shear rate viscosities. It is colored bright yellow to permit instant recognition of possible leaks. According to company technicians, Irus Fluid 902 can replace any conventional mineral or synthetic oil hydraulic system, and can be installed without modification of lines, pumps, valves or cylinders. Also, the fluid is said to have no effect on packing materials, seals or hoses, and to be suitable for use in most industrial vane and gear pumps. Irus Fluid 902 is reported to cost up to one-third less than synthetic oils. Shell Oil Co.

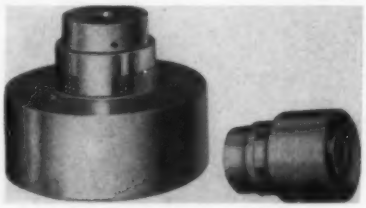
13—THERMOSTAT, heavy duty, controls two separate circuits

Two independent electrical circuits can be controlled simultaneously with the Series 22000 Thermoswitch, it is announced. Basically this dual control thermostat consists of a liquid-filled sensing element, containing a sensitive bellows-and-push-rod assembly which actuates two precision miniature snap switches mounted in the head. Each switch may be connected to operate a separate electrical circuit. The thermostat can be specified to operate over one of the three temperature ranges: −75 to 125 F; 25 to 225 F; and 100 to 300 F. Each switch can be set in the field to actuate at any temperature within the service range. A differential setting arrangement is also available.

Applications for this thermostat include control of heating and cooling equipment in a constant temperature process; step control of a process to actuate various dampers, valves, recirculating lines etc., in response to two critical temperatures; control plus high-limit cut-off or alarms. Switches are available to handle up to 20 amp at 125 or 250 v a-c or 10 amp at 125 v d-c. Fenwal Inc.

14—FLEXIBLE COUPLING has space-saving feature

Incorporating a brake drum flange on the outer diameter, this coupling provides a compact drive arrangement and is particularly useful where shaft length or distance between two units is at a premium. In effect, company notes, brake drum entails no more space than required by flexible coupling. Brake drum coupling is available in eight standard sizes, with horsepower ratings from 2 to 40 at 1750 rpm. Maximum



bores of hub body range from 1 to 2 ½ in. Drum body bores are made to motor shaft size specifications. Distance between shafts runs from ½ to 1⅝ in. Cushions are one-piece spider type. Lovejoy Flexible Coupling Co.

15—UNIT HEATERS supply fresh, warmed air to building

The FAS Unit Heater is for replacement of air exhausted in manufacturing processes and for comfort of personnel. It consists of a motor and fan, a heater section comprising alternate heating and by-pass passages, and a distributing outlet. Air brought in through by-passes is not heated. Volume control dampers on all passages, operated by synchronized damper motors, are actuated by air-stream or room thermostat. Dampers on heating passages move toward "open" position and dampers on by-passes move toward "close" position, or vice versa, depending on temperature requirements. When outdoor temperature is lower than desired indoor temperature, the dampers on the heating passages open and those on the by-passes close to the degree needed to produce required temperature.

Steam pressure in the coils is the same as in the supply main at all times, says manufacturer, so that the coils cannot freeze. Heaters come in two types: a

They licked a problem— before it happened— with STANODIESEL Oil M

How Sturgis light plant planned ahead to eliminate source of possible power shut down

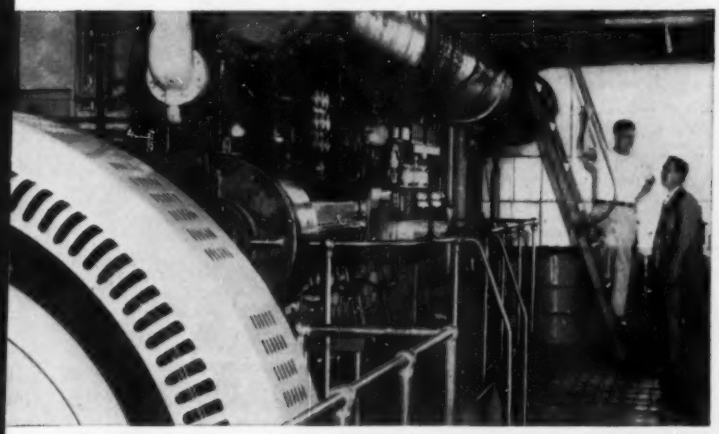
Sturgis, Michigan, light plant management in 1946 determined that it might be difficult to satisfy all power requirements if the light plant's large engine, or more than one of its small engines, was down. The plant is equipped with 5 engines—four GM 1,600 H.P. and one Busch-Sulzer 2,475 H.P. Plant management rightly figured that one of the keys to the problem was good lubrication. So, in 1946, STANODIESEL Oil M was tested in one General Motors engine.

In 1947, based on its performance during the test, all engines were converted to STANODIESEL Oil M. In the nine years since, the plant has never had to shut down power to customers because of engine or oil failure. There have been no wear problems. Engines have stayed clean. There is no ring sticking. Bearing life is exceptional.

STANODIESEL Oil M can give this kind of performance for two big reasons: (1) its highest quality base stock, (2) its additive formula. STANODIESEL Oil M has superior stability. An oxidation inhibitor helps to prevent unwanted increases in oil viscosity. Detergent-dispersant additives keep crankcase, pistons, cylinder walls and other parts clean. An anti-foam agent controls foam.

There's a Standard Oil industrial lubrication specialist near you in any of the 15 Midwest or Rocky Mountain states. Call him for more information about STANODIESEL Oil M. Or write Standard Oil Company, 910 S. Michigan Avenue, Chicago 80, Illinois.

J. J. Threlfall, superintendent and Donald Cripps, Standard Oil lubrication specialist check Don's data book on Sturgis light plant diesels. Don is well qualified as a lubrication specialist. He has been doing this work for nine years. He has an engineering degree from Michigan State University and is a graduate of the Standard Oil Sales Engineering School.



Sturgis, Michigan, light plant has four GM 1,600 H.P. engines and this Busch-Sulzer 2,475 H.P. engine. Engines receive progressive maintenance at 3,500 to 4,000 hours. STANODIESEL Oil M is used in all engines.

Quick facts about
STANODIESEL Oil M

- Keeps crankcase, pistons, cylinder walls clean.
- Combats deposit and wear problems imposed by use of economy fuels.
- Maintains film on difficult to lubricate areas and parts.
- Eliminates spark plug fouling in spark ignited engines and reduces combustion chamber ash deposits in engines burning natural gas, LPG and liquid fuels.
- Eliminates fuel injector and pump sticking caused by deposits on injector barrel and plunger where fuel and lube oil commingle.

STANDARD OIL COMPANY
(Indiana)

STANDARD

For more data circle 532 on Post Card

vertical flow type for roof or ceilings of single-story buildings or top floors of multi-story ones; and a horizontal type for windows or wall openings. Bulletin FAS-1 gives more information about heaters. L. J. Wing Mfg. Co.

16—INSULATING BLANKET for higher temperature use

Made of fine, closely intertwining aluminum silicate fibers, the Fiberfrax Blanket is said to keep its form and properties despite elevated temperatures — the material will stand 2300 F, says company. Because of its insulating qualities, a high thermal gradient through a minimum thickness of the blanket is effected, it is noted. Applications for the blanket include high pressure steam lines, diesel exhausts, gas turbines and furnace ducts. Because it possesses high

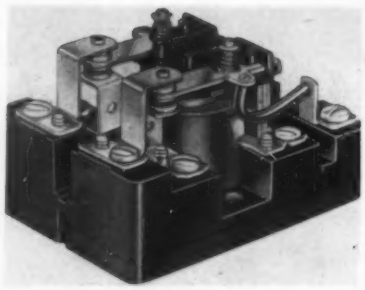
chemical stability, the material is also suggested for insulation lining in alloy and refractory furnaces. It comes in 25-ft rolls, is 12 in. wide and ½ in. thick. The Carborumdum Co.

17—WATER CHILLERS for air conditioning, cooling uses

Available in capacities from 20 through 150 tons, the Type CC Water Chillers are packaged units. Each consists of base and framework, reciprocating type Freon-22 compressor, direct expansion chiller section, heat exchangers, control panel, electric drive motor and associated valves, strainers and gages. Across-the-line magnetic motor starters are standard equipment. A major component in the chillers is a new copper tubing with star-shaped aluminum insert. This new tubing has more than double the heat-transfer surface of plain tubing, says manufacturer, and adds 25 per cent more cooling capacity per cubic foot of chiller size. American Blower Corp.

18—POWER RELAY is compact, heavy-duty type control

This 25-amp, heavy duty power relay is compactly designed to meet space limitations of equipment now using bulkier, heavier controls, it is announced, yet its electrical characteristics are equivalent, or even greater. Company reports that present applications include motor starting, heater loads and heavy industry control systems. In addition to switching heavy current or high voltage loads, unit incorporates the "interchangeable coil" feature. By removing two easily accessible screws, complete coil assembly



can be removed and replaced by a coil of same or different value ranging from 6 to 230-v a-c. No solder connections are necessary when changing coils. Contacts are heavy duty type and are rated at 25 amp, continuous duty, at 230-v a-c, with 75 per cent power factor load. Standard unit is double pole, double throw, and measures 3⅜ by 2½ by 2 3/16 in.; weighs 11 oz. Circular PR-10 gives details. Guardian Electric Mfg. Co.

19—CIRCUIT BREAKER to protect dual voltage equipment

This dual-rated circuit breaker is offered for protection of equipment designed to operate on either of two different voltages — such as 6 and 12 v d-c or 110 and 220 v a-c. Each breaker has two ratings, for example: 2 and 4 amp, 5 and 10 amp, etc., with separate load connections for each rating. Although most ratings supplied to date have had current ratios of two and one, the company says it can manufacture circuit breakers with current ratios of up to four to one. Minimum and maximum ratings are 1 amp and 40 amp. It is explained that due to hydraulic-magnetic operation, ratings are unaffected by ambient temperatures. Dual-rated circuit breakers are available with one of three inverse time-delay characteristics or in an instaneous-trip form. Maximum voltage is 480 a-c, 125 d-c. As yet manufacturer has not standardized on any particular rating, and will evaluate individual requirements. Bulletin 3430 gives more information. Heinemann Electric Co.

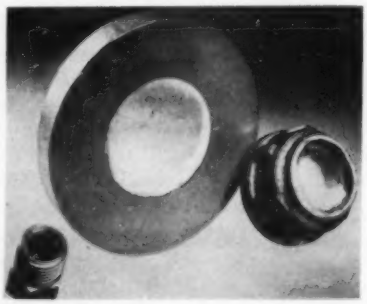
20—FLUORESCENT LAMP provides much more light

Termed the VHO (very high output) this standard shaped fluorescent lamp is claimed to provide two and one-half times as much light as conventional models. First two models in the line include a 100-w 4-ft lamp rated at 6200 lumens, and a 200-w, 8-ft lamp of 13,250 lumens. According to manufacturer, the VHO has four outstanding features: more efficient lamp diameter; rapid start continuous filament heating; "pressure control" center; and use of neon gas instead of argon. It is explained that the best mercury vapor pressure and temperature conditions for highest efficiency are narrow in limits, and that the "pressure control" center built into the lamp structure makes these possible — and that with these conditions, neon is superior to argon.

The new lamps use the same type of recessed double contact base as the high output rapid start lamp family, it is announced. Push-pull lampholder design permits the same "back-to-back" spacing for both HO and VHO types. Broad in application possibilities, the new lamps are suggested for high bay plant lighting, as well as medium and low bay use. Outdoor uses include parking lots and storage areas. Because of its very high output, the VHO is reported both a dollar saver and a space saver. Where conditions require four conventional lamps, for example, only two VHO Fluorescent Lamps would be needed, the manufacturer points out, and the fixture can be of conventional size. Sylvania Electric Products Inc.

21—SIGHT GLASSES are improved, long-wearing type

These sight glasses require neither solder nor gaskets. According to manufacturer, a new process makes possible a long wearing unit in which the glass is hermetically sealed directly to the metal. Company says it can produce to a plant's own specification, windows which are tamperproof, unaffected by aging or vibration and resistant to high pressures. The windows can be mounted in



almost all ferrous and non-ferrous metals, including brass and stainless steel.

Manufacturer reports production of sight glasses using the direct seal process in diameters from less than 3/16 to more than 3 in., and in window thicknesses from 1/16 to ¼ in. Possible sizes are not restricted to these, it is indicated. Pressure resistance of the windows is dependent on the size and shape of the individual unit. Corning Glass Works.

22—PLASTIC INSULATION features easier workability

Franco-Therm is a plastic insulation for application where easier workability and tighter adherence is required than that afforded by regular plastic insulations. Tests are reported to show that it develops no shrinkage and is waterproof, and that it will absorb hot or cold water and no destruction will take place. According to manufacturer, the material also resists destruction by boiling water and can be re-used. Intended for use to 1800 F, Franco-Therm dries white, and is described as having low thermal conductivity and being resistant to abrasion, vibration, impact and rust. It is suggested for use around air ducts, boiler settings, boiler drums, breechings, burner casings, economizers, heat exchangers, hot air lines and similar applications. J. H. France Refractories Co.

23—REGULATORS for the smaller welding shops

Airco Series 8000 Regulators are low-priced, inverse-type oxygen and acetylene pressure regulators designed to meet the needs of the smaller metal fabrication shops where initial costs are

Now you can buy a

Bailey-built HEAT PROVER Analyzer

CONTINUOUS READINGS OF OXYGEN AND COMBUSTIBLES

The famous Cities Service HEAT PROVER Analyzer, formerly available only on loan, is now manufactured by Bailey Meter Company, and you can buy one outright. With this handy portable instrument, you can easily monitor the per cent of oxygen and combustibles in gases.

The continuous readings from a Bailey HEAT PROVER Analyzer enable furnace, kiln, and engine operators to correct combustion variables before costly losses are incurred. Although it weighs a scant 25 pounds, the HEAT PROVER Analyzer is the key to maximum combustion efficiency. With it, the operator can determine the proper proportion of fuel to air at any time.

The two meters on the analyzer show per cent by volume of oxygen and combustibles on either a 20% range span or a more sensitive 4% range. Temperature of flue gases in degrees Fahrenheit is also shown.

Compared with involved, time-consuming Orsat measurements of flue gases, this new portable analyzer offers these advantages:

1. Simultaneous direct readings of oxygen and combustibles.
2. Negligible time lag between combustion change and reading change.
3. Continuous sampling, analysis, and readings.
4. Convenient measurement of temperature.

Ask your Bailey engineer how you can use this instrument to increase combustion efficiency. Or, write today for more information on how this new Bailey HEAT PROVER Analyzer can pay for itself practically at once. G-39-1

Flue gas analysis with a Bailey HEAT PROVER Analyzer at a furnace stack. Per cent oxygen and combustibles is shown continuously.

Instruments and controls for power and process

BAILEY METER COMPANY

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In Canada—Bailey Meter Company Limited, Montreal

BAILEY METERS

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BELMONT "Compressor"

stays flexible under intense dry heat

Here is an Air Compressor rod packing designed to thrive on gruelling service.

Belmont "Compressor" No. 760 asbestos packing is lubricated strand by strand, braid by braid, layer by layer to retain its flexibility and good sealing qualities for life—while protecting compressor rods from premature wear.

Another leader in the Belmont Line of "Custom-made for the Service" packings.

Use it for longer life, fewer maintenance jobs.

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Philadelphia 37, Pennsylvania

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a factor. Compact in design, the two-gage type measures 4½ by 4½ in. and weighs 2 lb, 4 oz; the single gage regulator measures 3½ by 5½ in., weighs 2 lb, 1 oz. The body is a machined brass forging and the spring case is a zinc die casting. For maximum readability, the brass pressure gages have crowned, clear crystals. Other features announced include: molded rubber diaphragm with fabric insert for strength, easy accessibility to internal parts, as well as relief valves. Air Reduction Sales Co.

24—BUSHING for transformers rated above 5 kv

This high voltage bushing features a hard rubber hand-grip insulated connector for protection against service interruptions caused by birds and/or animals, coming in contact with live parts. The hand-grip connector also permits quick, easy line installation, says company, and without tools. Connections are made by simply turning the hand grip. Kuhlman Electric Co.

Reader Service Cards on pages 125–126 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

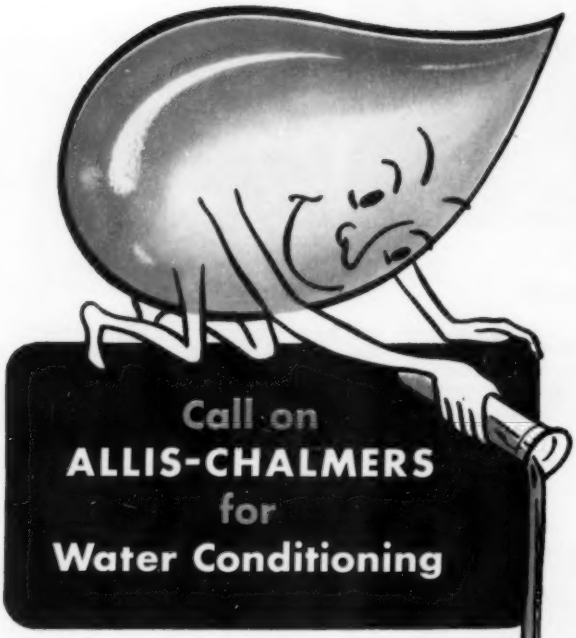
25—PNEUMATIC COMPUTER measures pressures, ratio

The Model PR-O Computer is a pneumatic pressure-ratio computer designed to measure compressor inlet and outlet pressures and simultaneously calculate the ratio of these two pressures. Outstanding features announced for it are wide range, flexibility, accuracy and pneumatic signal transmission. Pressure ratio is a key variable which must be regulated in order to prevent flow instability or surge in exhauster, compressor or blower control systems. The instrument indicates pressure-ratio on an integral scale and generates a pneumatic signal proportional to pressure-ratio for use in a control system. It can be used in other applications requiring the calculation of the ratio of two pressures.

The computer is available for application in ranges of static pressures of from 0 to 10 psia up to 0 to 400 psig. Higher static pressure ranges may be had. Available for computing on a gage or absolute pressure basis, the Model PR-O can also be supplied with a zero base or suppressed scale indication. Ratio calculating accuracy of the computer is claimed high even when the input static pressure turndown ranges are as great as 30 to 1. Bulletin MSP-103B gives complete information. Hagan Corp.

26—METERS transmit high pressure, high velocity flows

With these high-head differential pressure meters, high pressure, high velocity flows may be transmitted pneumatically on a linear flow basis, it is announced. Utilizing the accuracy of mercury U-tube measurements, they automatically convert a differential pressure to rate of flow. Outstanding features announced



Kill Algae

NEW, easy, low-cost way

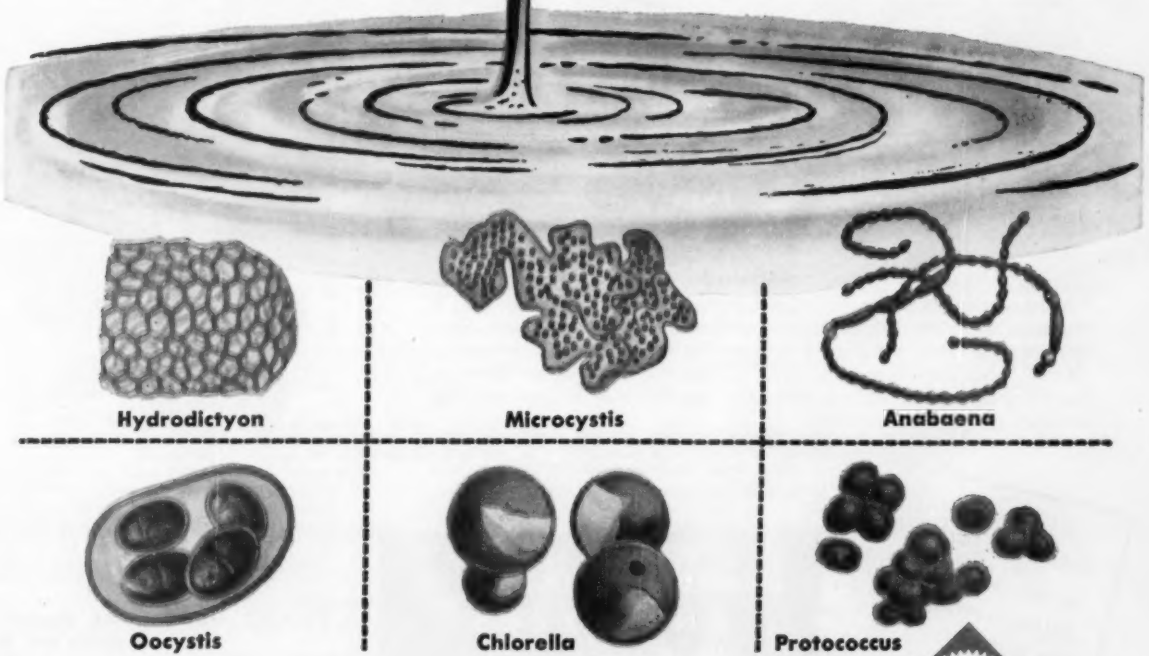
New Allis-Chalmers No. 120 Series Algaecide most toxic to all organisms in cooling towers

Many toxic materials used as algaecides are either difficult to handle (as in chlorination) or are effective against certain organisms, but not others. Fouling of cooling tower systems by algae and slimes results.

New No. 120 Series Algaecide succeeds when copper sulfate, potassium permanganate, quaternary ammonium compounds, sodium pentachlorophenate, and other complex chemicals offer only a partial solution to fouling conditions.

For complete information, call your A-C office, or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin, for Bulletin 28X8434.

As little as 2 ppm has killed all these algae



ALLIS-CHALMERS

A-5101

For more data circle 535 on Post Card

Now *simpler, more accurate control of oxygen in*

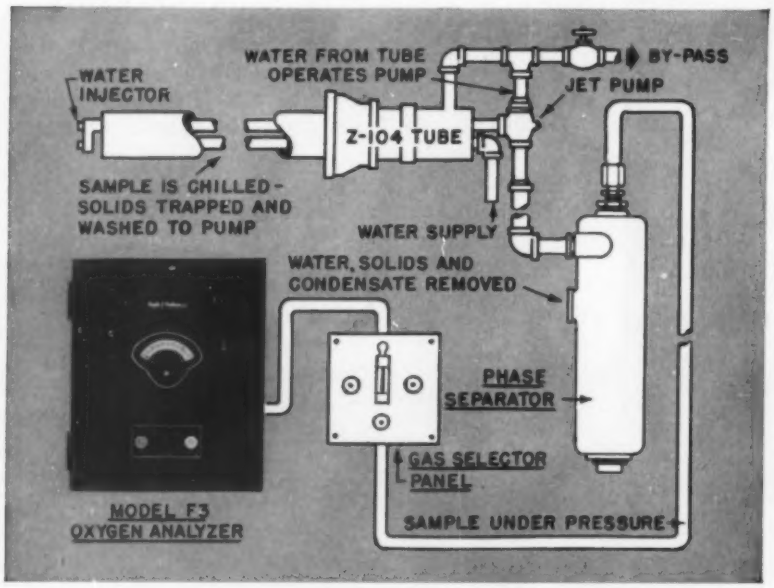
BOILERS...FURNACES...KILNS...DIRECT-FIRED HEATERS, ETC.

with Arnold O. Beckman INC.

complete Analysis Systems!

Arnold O. Beckman, Inc. – leaders in developing advanced instrumentation for accurate oxygen control – now offers *complete* analysis systems for higher combustion efficiencies at lower fuel costs.

These field-proven systems are already being used by progressive operators to boost profits, cut costs – and they will make the same savings for *you*. They consist of Analyzer, and Sampling System – all in one compact installation suitable for indoor or outdoor location. For severe temperature conditions, heated cabinets can be supplied.



The diagram (above) shows a typical analysis system for boilers. The incoming sample gas is first chilled and washed . . . then passes through a Separator where the condensables and solids are removed. The resulting clean, dry sample gas flows under pressure to the Gas Selector Panel (for selecting "Zero," "Span" and "Sample" gases) . . . then into the Analyzer where the oxygen content is quickly measured. The Analyzer may be used with any standard recorder or controller.

Result – new speed, simplicity and accuracy in controlling air-fuel ratios, with important savings in fuel and operating costs!

Get the full story on these Complete Analysis Systems by writing for Data File #19D-96.

Arnold O. Beckman INC.
ANALYZERS
Profit Builders for Industry
1020 Mission Street
South Pasadena, California

SEE THESE INSTRUMENTS AT THE ISA EXHIBIT, SEPT. 17-21
ALSO AT THE IRON & STEEL EXHIBIT, SEPT. 26-29

For more data circle 536 on Post Card

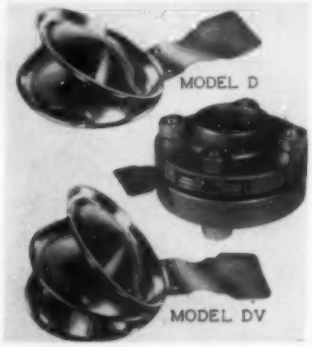
for these units are low cost, accuracy, rangeability, simplicity, and flexibility.

These transmitters measure the rate of flow of steam, water and other liquids and gases producing maximum differentials from 100 to 1200 in H_20. The

mercury U-tube is available for maximum service pressures of 800, 3500 and 6000 psig. Where mercury is undesirable, a bellows type is available for maximum service pressures of 1500 and 3500 psi. Signals are SAMA standard, 3–15 psig or 3–27 psig. Receivers may indicate, record and/or integrate. Product Specification P22-6 gives data. Bailey Meter Co.

27—RUPTURE DISC for the protection of pressure systems

This D and DV Rupture Disc is reported to extend the advantage of safety head protection to many installations now operating under pressure, temperature and corrosive conditions too severe for many such discs. This new disc extends the range for high temperature applications, provides maximum service under pulsating or reversing pressure conditions and permits closer operation to rupture pressure, according to manu-



facturer. It is also said to make lower minimum rupture pressures possible and give extended service under pressure surges that approximate the rupture pressure. Full details are in Catalog 77-31. Black, Sivalls & Bryson, Inc.

28—JET GUN cleans the condenser tubes out fast

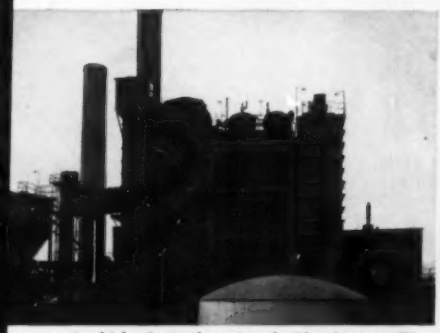
This super-jet condenser cleaning tool utilizes a gun-and-slug method to remove slime and scale and is reported to provide extremely fast cleaning. With it, one man can quickly load an entire bank with cleaning slugs and shoot them through in rapid succession, it is pointed

For lowest cost steam generation, *General Electric,* Louisville, Ky., burns coal the modern way.

At *American Cyanamid,* Bridgeville, Pennsylvania, power system modernization saves the firm $100,000 a year.

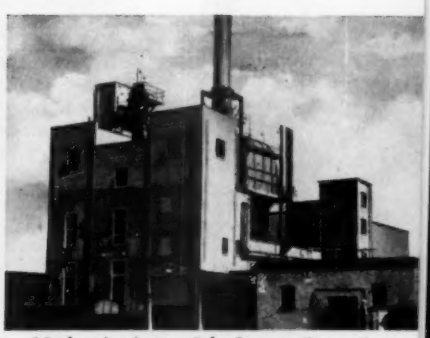
Burning coal the modern way at *Pennsylvania RR's* Juniata shops in Altoona saves $500,000 a year.

Each year more firms



Carbide & Carbon, South Charleston, W. Va., saves $470,000 a year in lower costs and increased efficiency.

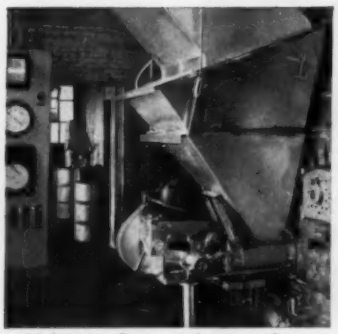
Coal costs 40% less than the next cheapest fuel at *Pinehurst, N. C.* resort . . . modernized plant 33% more efficient.



Modernization at *John Strange Paper Co.,* Menasha, Wis., reduced power costs and increased plant production 10%.

are burning coal the modern way

Modernization by *Clark Equipment Co.,* Battle Creek, Mich., supplies power for expanding production facilities, saves $7,500 annually.



Using modern equipment, *Scandinavia Belting Co.,* Charlotte, N. C., has increased steam capacity 150%, cut fuel costs 15% and reduced labor costs 70%.

Modernization gave *Kalamazoo Vegetable Parchment Co.,* Kalamazoo, Michigan, increased steam with lower fuel and operating costs.

Burning coal the modern way resulted in "peak efficiency and economy" for *Garlock Packing Co.,* Palmyra, New York.

for efficiency and economy

facts you should know about coal

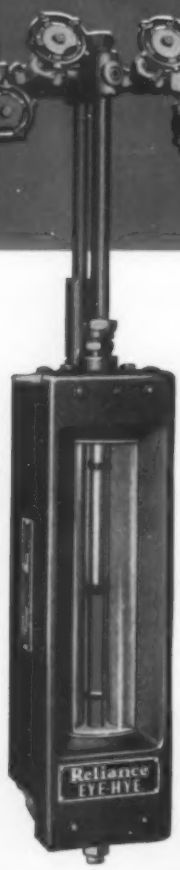
In most industrial areas, bituminous coal is the lowest-cost fuel available • Up-to-date coal burning equipment can give you 10% to 40% more steam per dollar • Automatic coal and ash handling systems can cut your labor cost to a minimum • Coal is the safest fuel to store and use • No smoke or dust problems when coal is burned with modern equipment • Between America's vast coal reserves and mechanized coal production methods, you can count on coal being plentiful and its price remaining stable.

For further information or additional case histories showing how other plants have saved money burning coal, write to the address below.

NATIONAL COAL ASSOCIATION
Southern Building • Washington 5, D. C.

For more data circle 537 on Post Card

Sharp visibility for *all* your liquid levels with EYE-HYE® Remote Reading Gage

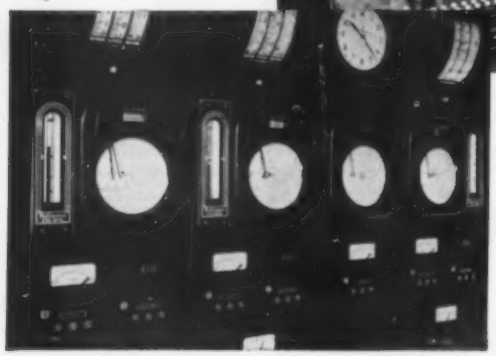


Most important for quick-reading mistake-proof gage equipment are your main boilers — naturally! But other liquid levels need watching — some that can't have "main floor" prominence or convenience.

EYE-HYE brings *all* gage reading out front, to a central point or to locations frequently passed by operators. (See list below.)

Simple, fool-proof, easy to read (illuminated green liquid represents water level), EYE-HYE is made for pressures up to 2500 psi — water level variation to 12 feet. New wide vision face plate makes reading visible from wide area. Write for specific recommendations to bring your gage facilities up to date.

Close-up of panel board section at an important research center where 3 EYE-HYEs serve the main boilers.



How EYE-HYE assemblies get hydraulic test at nearly twice their cataloged pressure rating.

Main boilers Flash tanks
Feed Water Heaters
Water treatment systems
Waste heat boilers
Storage tanks

The Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland 3, Ohio

For more data circle 538 on Post Card

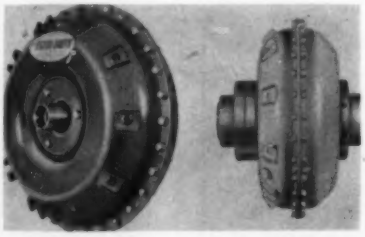
out. The gun is described as a rugged duty tool weighing only 2¾ lb. It can be operated by air or water pressure and effective pressures are 50 to 200 psi.

Three types of cleaning slugs in sizes to fit all standard tubes can be furnished, to handle cleaning under practically all conditions. Spool-type slugs, for normal slime removal, have a cup at the forward end which expands to wipe the inside of the tube. Bullet-shaped slugs are for removing thick slime de-

posits. Scraper-type slugs serve to cut away scale or mineral deposits as they are driven through the tube. The latter two types have "jet action" holes in the side wall to admit water or air for flushing away deposits as they are removed. Crane Packing Co.

29—FLUID DRIVE for general industrial use

Size 126 Type T Gyrol Fluid Drive is an improved traction type unit for use with internal combustion engines as a fluid power transmission for mobile material handling vehicles and construction equipment. Power rating in these applications is 25 to 85 hp, depending on drive speed. When modified by installation of a flexible half on each end of the drive, the



unit is declared suited to constant speed electric motor applications for driving production and processing equipment, machine tools and conveyors. As a motor driven unit, the drive is rated 7½ to 15 hp for 1200 rpm drive speed and at 25 to 50 hp for 1800 rpm. Dimensions for the basic unit are 7⅛ over the shaft and 14-$\frac{13}{16}$ in. OD. Over-all length for the electric motor arrangement is 10$\frac{13}{16}$ in. American Blower Corp.

30—JOINT COMPOUND in plastic squeeze bottle

No. 2 Electrical Joint Compound, for removing oxide film from aluminum or copper electrical conductors and fittings, is now packaged in a handy plastic squeeze bottle. Container holds 8 fl oz, is oval in shape to prevent rolling, and is described as easy to carry and use on the job. Each bottle is delivered sealed — merely pull off cap and nip off tip of spout. Bottle is recapped like an oil can. Aluminum Co. of America.

DE LAVAL OPPELLER PUMPS

last longer... cut maintenance costs

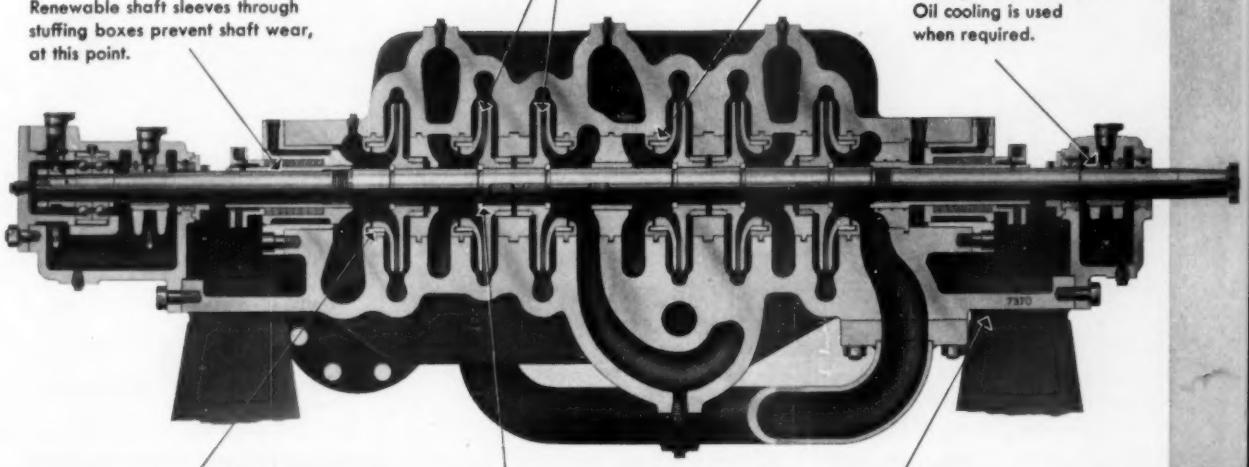
Stages are arranged to reduce differential pressures between stages. This insures permanent sealing at the casing-joint and at interstage diaphragms.

Pairs of back-to-back impellers balance axial thrust. One-purpose thrust bearing carries no radial load, maintains axial alignment.

Labyrinth wearing rings permit safe clearances and reduce wear.

All bearings are ring-oiled, sealed against contamination by water or dust. Oil cooling is used when required.

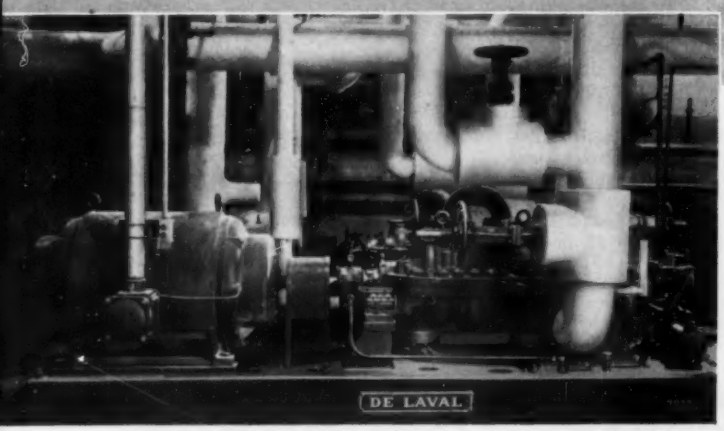
Renewable shaft sleeves through stuffing boxes prevent shaft wear, at this point.



Threaded impeller wearing rings make replacement easy without heating or damage to impellers.

Individual impeller mountings, with split locating rings, make interstage shaft sleeves unnecessary. Impellers can't shift with shaft expansion and contraction.

Casing support insures coupling alignment at any operating temperature.



Here are two De Laval 6-stage Oppeller Pumps used for boiler feed service in an industrial installation.

The design features above show clearly why De Laval Oppeller Pumps stay on the line longer and cost less to maintain. These pumps are used for boiler feed, hydraulic systems, descaling spray, mine dewatering, refinery oil pumping and similar services.

De Laval Oppeller Pumps are available in sizes from 2 to 4 inches and 2 to 8 stages; capacities to 1000 gpm, pressures to 1200 psig and temperatures to 350F.

DE LAVAL *Oppeller Pumps*

DE LAVAL STEAM TURBINE COMPANY

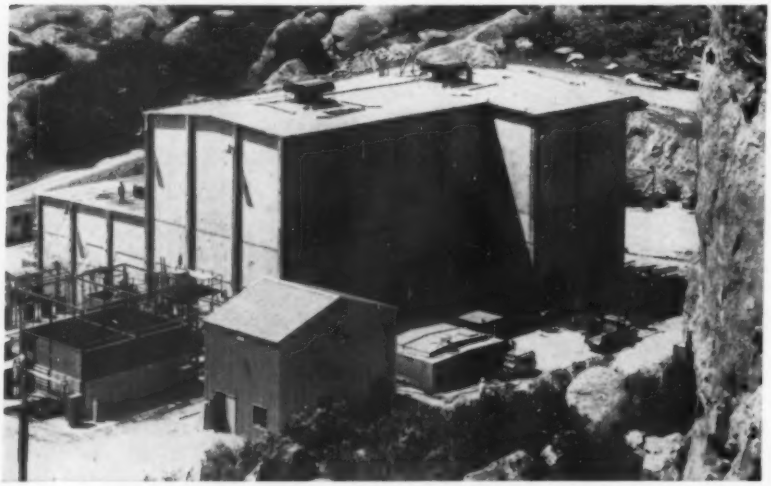
816 Nottingham Way, Trenton 2, New Jersey

DLZ86

NUCLEAR NEWS FROM ATOMICS INTERNATIONAL

Nuclear reactors now being built for science and industry—for power and radiation

Within a single decade ATOMICS INTERNATIONAL engineers and scientists have developed a broad range of experience in the nuclear field through the design, construction and operation of a wide variety of reactors. This work includes four reactors completed and now in operation; four more reactors now in construction; and seven major engineering design projects completed.



Sodium Reactor Experiment nears completion in Santa Susana Mountains. It is being built and will be operated by Atomics International as a key part of AEC's nuclear power development program.

ATOMICS INTERNATIONAL, a division of North American Aviation, Inc., is a leader in the development of advanced reactor technology. A new power reactor concept, the Organic Moderated Reactor Experiment, is scheduled to be built by ATOMICS INTERNATIONAL for the Atomic Energy Commission at the National Reactor Testing Station in Idaho. This promising experiment will use an organic material—a carbon-hydrogen compound—in the dual role of moderator and coolant.

The diversified nuclear program at ATOMICS INTERNATIONAL includes:

1. Sodium Reactor Experiment. Located in Santa Susana Mountains, near Los Angeles. Fuel: either slightly enriched Uranium, or Thorium and U-233. Output: 20 Thermal Mw. Though experimental, the reactor will be equipped with heat exchanger and turbogenerator by Southern California Edison, who will feed 6.5 Mw of electric power to the surrounding area.

2. Full-scale Sodium Graphite Reactor Design. Fuel: same as above. Heat output: in the order of 250 Thermal Mw. Power Output: Uranium—75 Mw; Thorium—100 Mw; Thorium (after further development)—125 Mw. Capital costs, with full generating equipment, around $300 per Kw with Uranium, expected to be reduced with Thorium eventually to $200 per Kw. Power costs would thus decrease from 11.1 mills/kwh to 6.5 mills/kwh.

3. Water Boiler Research Reactor. Designed and built by ATOMICS INTERNATIONAL for use on Atomic Energy Commission research projects. Fuel: enriched Uranium. Power 5 watts. Flux: $10^{n}n/cm^{2}/sec$ (thermal). Experimental facilities include exposure holes, through-tube and vertical thermal column.

4. Livermore Research Reactor. For Atomic Energy Commission's laboratories at Livermore, Calif. A higher power version of the Water Boiler Research Reactor designed to operate at 500 W. These were the first two reactors in California.

5. Medical Research Reactor. Designed for a southern California university. Fuel: Uranyl sulphate, highly enriched with U-235. Power: 50 kilowatts. Thermal neutron Flux: 1.7 x $10^{12}cm^{2}/sec$. Provision for gamma intensities to 1.3 reb/min per kw, fast neutron intensities of 4 reb/min per kw; also utilization of pure gamma activity of fission gases. Excellent exposure facilities for patient therapy and biological research. First reactor specifically designed for medical use.

6. Industrial Research Reactor for Armour Research Foundation of Illinois Institute of Technology, Chicago. Similar to 5 above, with experimental facilities for industrial applications. This reactor is now operating on a planned schedule that includes "time" for participating companies. This is the first reactor designed specifically for private industrial research.

7. General Research Reactor for Atomic Energy Research Institute, Japan. Similar to the Armour and Medical Research reactors described above. This will be the first nuclear reactor in the Far East, and is slated to be completed in 1957.

ATOMICS INTERNATIONAL has complete designs for reactors with a variety of fuel moderator and cooling systems for various applications, and offers a complete program of services in connection with all reactor projects, including:

- Advice on most suitable reactor type for a specific use
- Assistance in reactor site selection
- Aid in meeting AEC requirements
- Coordination of reactor plans with building plans
- Installation supervision
- Training of operating and maintenance personnel
- Assistance in fuel loading and initial reactor operation
- Design counsel in later modification or expansion
- Assistance in public information

Dr. Marlin Remley of Atomics International activates Armour Reactor—first for private industry.

If you are interested in any phase of our activities, ATOMICS INTERNATIONAL is staffed and equipped to help you. Please write: Director of Technical Sales, Dept. PE-N5, ATOMICS INTERNATIONAL, P.O. Box 309, Canoga Park, California. Cable address: ATOMICS.

ATOMICS INTERNATIONAL
A DIVISION OF NORTH AMERICAN AVIATION, INC.
PIONEERS IN THE CREATIVE USE OF THE ATOM

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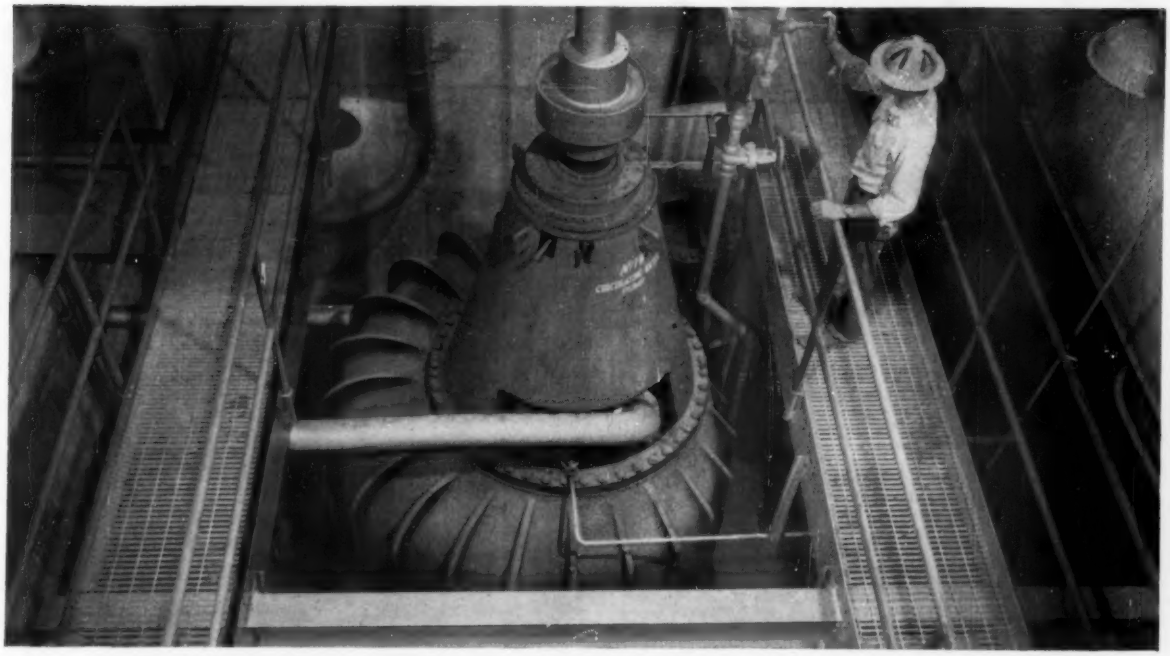
Allis-Chalmers

PUMPS Meet Power Plant Requirements



Heavy-Duty Construction Helps Assure Service Continuity

At Clifty Creek Plant of the Indiana-Kentucky Electric Corporation, the use of 12 Allis-Chalmers vertical condenser circulating pumps for dry pit installation helps to assure service continuity and reduced maintenance.

Rigid whip-free shaft, protected oil-lubricated bearings, and special new-type rib construction that makes casing stronger and saves space — these are some of the features that make A-C circulating pumps popular throughout the power industry.

For the complete story on how Allis-Chalmers pumps can help you cut costs, contact your local Allis-Chalmers district office, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wis.

You get **MORE**... when you specify ALLIS-CHALMERS

Design and construction features like these assure dependable, day-after-day operation — better performance and low operating costs for you.

Benefit from Allis-Chalmers experience in building pumps for every industry. Industry-trained engineers are at your service to aid in selecting the right pump for your application. And, you can get the complete unit — pump, motor, control — from Allis-Chalmers.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-4973

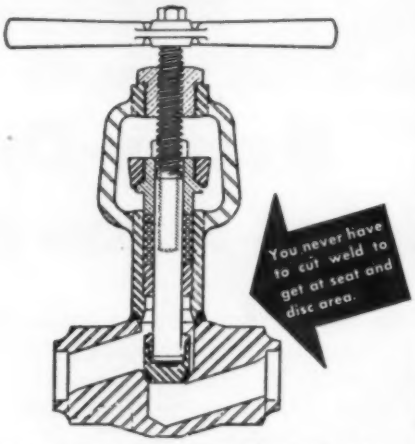
For more data circle 541 on Post Card

Cut valve maintenance up to 75%

Install HANCOCK 1500# and 2500# Steel Valves

• Every power plant maintenance man will agree that a lot of valuable time is lost when hours must be spent in servicing a single high pressure valve. That is why Hancock 1500# and 2500# Steel Valves are preferred for high-temperature steam lines. They rarely require attention, but when maintenance is needed, the work takes as little as one-fourth the time ordinary high pressure valves demand. Hancock Valves stay in the line for servicing. There is no danger of ruining internal parts. The bonnet weld is permanent—never has to be cut to get at the seat and disc area.

Most design and operating engineers in modern steam plants specify these high pressure Hancock Valves with maintenance requirements in mind. There is no bonnet joint to leak, no gasket to leak, no seat insert to leak! In design, in quality, in construction—in every respect—Hancock 1500# and 2500# Steel Valves have every feature essential to protect personnel, plant and service to customers. So, when you replace high pressure valves, remember that *when Hancocks go in, valve costs go down!*



SIZES: ¼" through 2". Outside screw and yoke.

SERVICE RATINGS: Screwed and socket weld ends: For all pressures up to 2500 psi at 1050° F., O.W.G. 6000 psi—100° F.

Flanged Ends: For all pressures up to 1500 psi at 900° F., O.W.G. 3600 psi—100° F.

Integral hard faced seats, hard faced discs.

CALL YOUR INDUSTRIAL SUPPLY DISTRIBUTOR for help in meeting your needs for revalving projects and new construction. You can depend on his recommendation to save you time, trouble and expense.

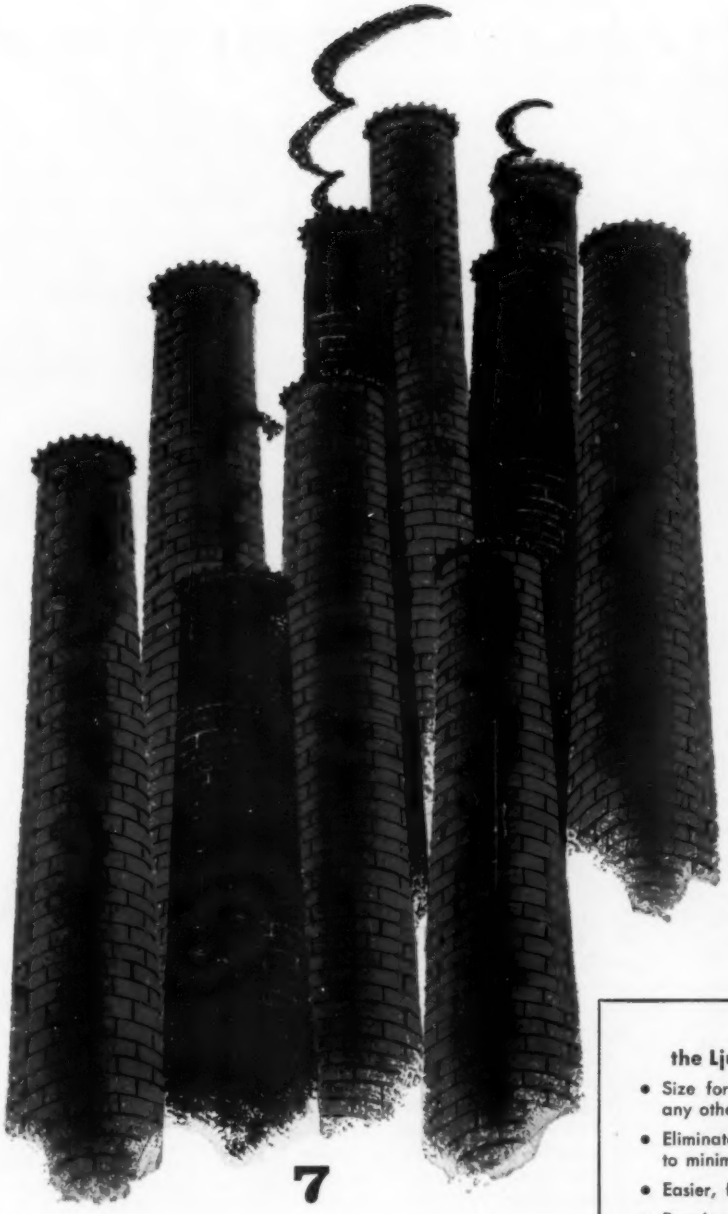
In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

HANCOCK VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** Watertown 72, Massachusetts

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

For more data circle 542 on Post Card



Advantages of the Ljungstrom Air Preheater

- Size for size, recovers more heat than any other type.
- Eliminates cold spots . . . keeps corrosion to minimum.
- Easier, faster to clean and maintain.
- Requires far less supporting steel and is quickly erected.

7 out of 10 . . . air preheater installations are Ljungstrom®

MAXIMUM HEAT RECOVERY is one important reason. As a general rule, a height of one inch of the heating surface used in a Ljungstrom Air Preheater will recover about as much heat as one foot of length of the standard surface of conventional type air preheaters. For the interesting full story, send for a free copy of our 38-page manual.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

For more data circle 543 on Post Card

CONDENSER TUBE CLINIC

Edited by **ARTHUR W. TRACY**, Metallurgical Engineer,
The American Brass Company, Waterbury, Connecticut

Stresses and their Effects can be Minimized

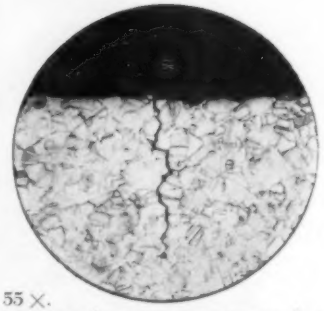
STRESS-CORROSION CRACKING—The stress-corrosion cracking of copper alloys requires the simultaneous action of moisture, air, ammonia, and stress. Stresses may be residual or applied. All Anaconda condenser tubes are processed so as to minimize residual tensile stresses which may be formed during fabrication. Applied stresses from installing tubes in heat exchangers, nonuniform thermal expansion in tube bundles, or misalignment of condensers with other equipment occasionally cause stress-corrosion cracking.

Admiralty metal and aluminum brass tubes, although known to be susceptible to stress-corrosion cracking, seldom crack in condensers. Although ammonia is often present, either by chance or design, in vapors entering condensers, the amount of air (oxygen) is usually so small that the corrosive action of the ammonia is limited. It is obvious that noncondensable gases should be vented from condensers, not only to increase thermal efficiency, but to minimize corrosion.

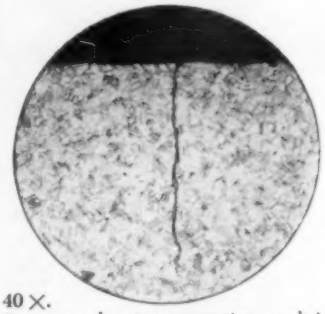
ANACONDA Arsenical Admiralty-439 and ANACONDA Ambraloy-927 condenser tubes seldom stress-corrosion crack in normal service. Where operating conditions are severe enough to cause stress-corrosion cracking of these alloys, ANACONDA Cupro Nickel, 10%-755 and ANACONDA Cupro Nickel, 30%-702 tubes are recommended.

FATIGUE CRACKING—Vibrations from moving parts of equipment or from pressure pulsations can induce stresses in condenser tubes high enough to exceed the endurance limit and cause a fatigue-crack failure. Vibration of a tube may even disturb water flow enough to cause impingement pitting at the point of greatest amplitude of vibration and the resulting pits can act as stress raisers. Pulsations can often be dampened by placing baffles or grids in the path of high-velocity vapors. Vibration of tubes can also be dampened by placing wooden slats between rows of tubes. Cupro Nickel, 30%-702 Tubes are more resistant to fatigue cracking than admiralty and aluminum brass.

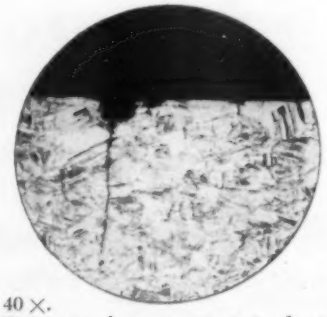
TECHNICAL ASSISTANCE—Your tube problem may need special consideration. We are always ready to advise in the selection of the right alloy to give the best service. Write for the new edition of Publication B-2. The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 6879



55 ×.
Intergranular stress-corrosion crack in 70/30 brass tube from oil refinery heat exchanger. Longitudinal section.



40 ×.
Transgranular stress-corrosion crack in admiralty metal tube from oil refinery heat exchanger. Longitudinal section.



40 ×.
Fatigue crack starting at pit in aluminum brass tube from power plant condenser. Longitudinal section.

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Nominal Compositions of Some Anaconda Condenser Tube Alloys

	Arsenical Admiralty -439	Ambraloy -927 (Aluminum Brass)	Cupro Nickel, 10%-755	Cupro Nickel, 30%-702
Copper, %	71	77	88.35	68.90
Nickel, %	..	..	10	30
Zinc, %	27.96	20.96	..	..
Aluminum, %	..	2	..	..
Tin, %	1	..	..	..
Arsenic, %	0.04	0.04	..	..
Manganese, %	..	..	0.40	0.60
Iron, %	..	..	1.25	0.50

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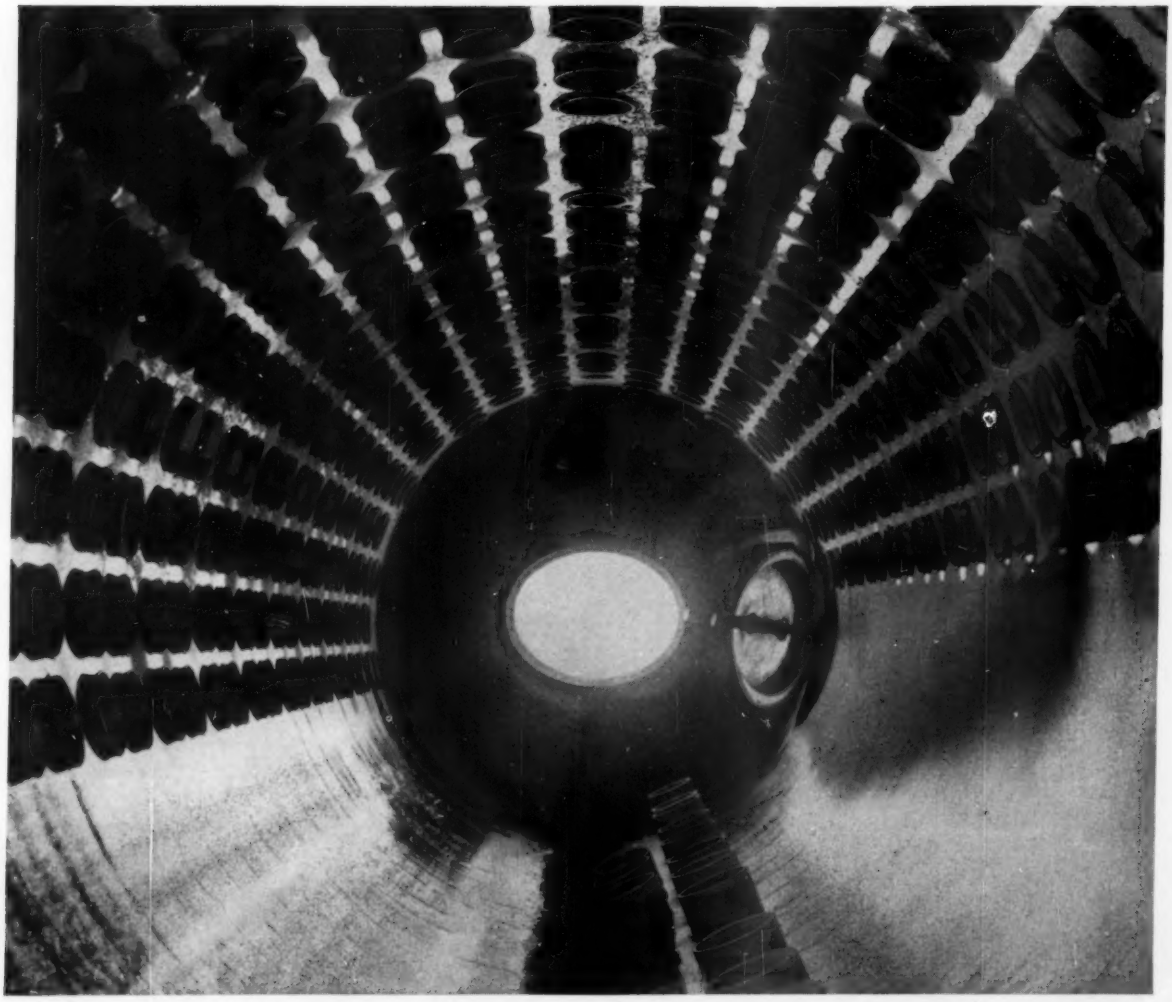

Mud drum interior of Boiler No. 9, American Motors Co., Kenosha, Wis.

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Not only Preferred Utilities, but many other leading manufacturers of package-type boilers now furnish YARWAY Blow-Off Valves on their units. YARWAYS make a *good* package boiler *better*.

The YARWAY Seatless Valve gives drop-tight shut-off and also eliminates the commonest source of blow-off valve trouble. *There is no seat to score, wear, clog or leak.*

Whatever make boiler you use, specify that the blow-off valves be YARWAY *Seatless*. More than 16,000 boiler plants use YARWAY Blow-Off Valves—some for 35 to 40 years.

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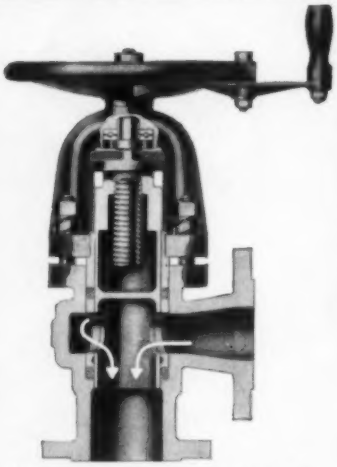
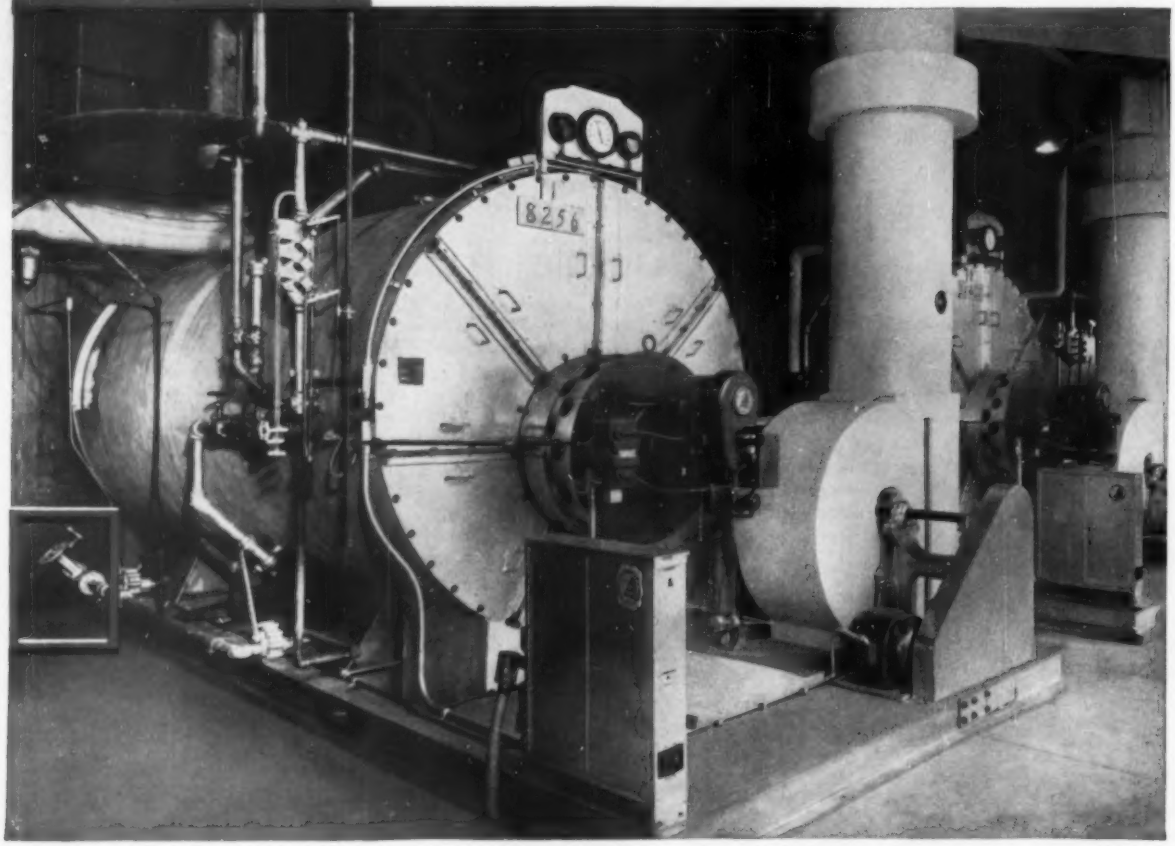


Yarway Type "B" Seatless Blow-Off Valve shown in open position. Note balanced, sliding plunger design. There is no seat to score, wear, clog or leak. Pressures to 400 psi.

YARWAY BLOW-OFF VALVES



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Fifth World Power Conference Vienna 1956

Fig. 1. Theodor Körner, President of the Austrian Federal Republic, addressing the opening session of the Fifth World Power Conference in the new Vienna State Opera House

"The serious work of this great conference will result in new points of view and further knowledge in our field of study. It will not always be possible to reach an immediate solution of the problems raised, but no doubt ways will be discovered which will one day prove successful. . . .

". . . more than any other source of energy ever before, nuclear energy provides the great unknown factor . . . we hope that the darkness still prevailing in this field will in some way be dispelled."

Dr. h.c. THEODOR KÖRNER

President, Austrian Federal Republic

"We are living in an age of rapid economic expansion, more rapid in industry, alas, than in agriculture, for food is the world's greatest need today with the perilous increase in the world population—a reminder to us of the dangers that may come from an unbalanced use of man's new power to alter his environment."

Sir HAROLD HARTLEY

President, World Power Conference

"We all recognize that in the field of world energy we stand before tremendous new and pioneering tasks and it is singularly fitting that we should deliberate about these matters in this now free capital of one of the youngest members of the United Nations."

GAIL HATHAWAY

Chairman, U. S. National Committee, World Power Conference

Fifth World Power Conference Vienna 1956

By **RICHARD H. MORRIS**
Editorial Director
and
ANDREW W. KRAMER
Editor
POWER ENGINEERING

Fig. 2. Aerial view of Vienna, where the 1956 World Power Conference was held

WITHOUT QUESTION, the development of atomic power was the subject of greatest interest to the more than 3000 engineers, scientists and other representatives of the 50 nations who attended the Fifth World Power Conference in Vienna, Austria, from June 17 to June 24. While all aspects of power development were discussed, the development of nuclear power was given the greatest amount of attention. Every nation, large or small, expressed confidence in the future of peace-time atomic power development.

As pointed out by Sir Harold Hartley of Great Britain at the opening session, the possibility of harnessing nuclear energy has come at a most timely moment. The energy available in the uranium and thorium deposits has multiplied the energy resources of the world many fold. It will, in time, make ample energy supplies available at places where the cost of transporting traditional fuels may be prohibitive.

Six years have gone by since we last took stock of the world energy situation at the Fourth World Power Conference in London in 1950, and in those years much has happened. There is a growing awareness of the vital part that energy has to play in our modern civilization.

We are living in a century which has been marked by an unprecedented advance in man's understanding of nature, and it is a paradox of human destiny that the rapidity of that advance has been quickened so much by the catastrophe of war and the threat of war that human nature has brought upon itself. But the advance has come and it has placed in the hands of mankind a new source of power and vast new possibilities of a closer partnership with nature and all that it implies.

It was significant that this Fifth World Power Conference — the first of these great meetings to really sense the tremendous possibilities of atomic power for peace — should have been held in Vienna. For atomic energy offers mankind new hope for future happiness, and if any great city looks forward to a new future and a greater share of happiness and comfort, it is this war-torn city on the Danube.

After 15 years of war and occupation by enemy forces, Vienna today is understandably shabby and threadbare. But the war is over and the occupation forces have been removed, and so once again Vienna looks forward to the time when she can regain a measure of the joy and happiness that once prevailed here. And perhaps more than anything else atomic energy can help bring this about.

The opening session of the Conference was held in the great new Vienna State Opera House, a magnificent theatre with a seating capacity of over 3000. The address of welcome by the chairman of the Austrian National Committee was followed by the presidential address of Sir Harold Hartley, president of the World Power Conference. Following Sir Hartley's address was a lecture by Dr. Erwin Schrödinger who dealt not with the problem of world power but with the mystery of human consciousness and biological processes.

Next were short speeches by various national committee chairmen, including that of Gail Hathaway, chairman of the U. S. National Committee. Finally came the address and formal opening of the Fifth World Power Conference by Dr. h. c. Theodor Körner, president of the Austrian Federal Republic.

Austria's Role

President Körner pointed to the traditional role of Austria as a mediator and stressed the position of Vienna as a world center of culture. He stated that the city's reconstruction after the heavy war-time damage has by now been practically completed. Although, Dr. Körner indicated, for various reasons, Austria does not at present make remarkable contributions to nuclear research, she may still proudly call attention to one of her greatest sons, whose work has essentially furthered developments in this field, the philosopher and Nobel Prize winner for physics, Professor Erwin Schrödinger, whose lecture featured the opening session.

It was the sheer thirst for knowledge, not an attempt to reach a specific goal, that led Dr. Schrödinger to establish his theory of wave mechanics. According to Schrödinger, classical particles — electrons, protons, neutrons, etc. — are dissolved by a spectral distribution of waves and it is thus that we are able to understand the properties and reactions of atomic matter. Though strange at first sight, Schrödinger's ideas and equations have proved to be the best means we have of penetrating into the mysterious world of the atom.

In closing, President Körner stressed the importance of mutual acquaintance and private conversations between the participants of the Conference and hoped that the delegates would always connect this meeting with pleasant memories of their beloved Austria. "Please give us," he concluded, "your invaluable friendship, just as Austria and Vienna wholeheartedly and sincerely give you theirs."

Sir Hartley directed attention to the problems brought about by the great increase in the world's needs and desires, and also to the unbalance between industrial and agricultural development. We are living in an age of rapid economic expansion, more rapid in industry than in agriculture, and this, he said, is a source of danger. Food is the world's greatest need today with the perilous increase in world population.

While new developments in science and technology have brought new hopes and outlooks, at the same time they face mankind with the fact that natural resources are not unlimited.

In this modern world, Sir Hartley continued, energy, directly or indirectly, is playing a vital part, and often it may prove to be the limiting factor in a nation's development. There is therefore a growing awareness of the need of energy and a growing anxiety in many countries as

Fig. 3. Another view of Vienna, with 800-year-old St. Stephen's church at right

to how these needs can be met.

The discovery of the possibility of utilizing atomic energy comes at a timely moment. A year ago, at Geneva, the cloak of secrecy was lifted and much of the knowledge acquired so swiftly by the greatest concentration of science and engineering on a single project in the world's history was released for peaceful use. And now, with the experience we are sharing in the design and construction of nuclear reactors, we can see the picture in better perspective and estimate the probable time scale of nuclear development.

A great many problems remain to be solved and it is one of the purposes of the World Power Conference to try to find methods for solving them. The demand for electricity is growing continuously and by 1975 perhaps as much as 50 per cent of the intake of energy may be nuclear energy. Nuclear power stations will soon begin to take the place of those using fossil fuels such as coal, oil and gas.

The pattern of the energy economy in different countries will differ widely according to their needs and resources. With the heavy and long-term investment that is characteristic of the energy industries, it is essential for each country to foresee what that pattern is likely to be. For that reason the periodic surveys of the energy economy of each member country that are presented at the World Power Conference meetings are of special value.

The founder of the World Power Conference, Daniel Nicol Dunlap, had the vision, more than 30 years ago, to foresee the need for a forum where representatives of all the different nations could meet for the discussion of problems of mutual interest so that energy policies of the future might be formulated on the broadest front.

Fig. 4. Gail Hathaway, Chairman of U. S. Committee, addressing opening session

This, said Sir Hartley, is the purpose for which the World Power Conference was founded and it is a great tribute to Dunlap's imaginative conception that the wording of the original charter has remained practically unaltered.

In closing, Sir Hartley again pointed to the urgency of the world food problem. Food, he said, is the most urgent need of the world today, and "I would ask you to consider whether we are devoting enough thought to the place of power in agriculture as compared with the emphasis we place on industry, and whether the confidence of the less developed countries in the benefits of industrialization may not be deflecting too much effort away from agriculture." Mechanization, irrigation, rural electrification and transport are vital factors in the future of our food supply.

Sir Hartley said he was glad to see that the Jugoslav National Committee in their program for next year's sectional meeting have paid so much attention to the place of energy in rural life. We are apt to forget that the energy content of the foodstuffs on which life depends is as much as a quarter of the energy content of the fossil fuels we use today. We think of the intricacies of a nuclear power station but they are as nothing compared with the mystery of nature's power station in the human body in which she evades her own laws of thermodynamics by converting chemical energy into mechanical work at constant temperature.

Gail Hathaway

Gail Hathaway, the chairman of the United States National Committee, acknowledged the warm welcome which the Austrian hosts had extended and assured them that it would never be forgotten. "I have no doubt," he said, "that my fellow delegates from the United States and other countries share with me the pleasure and sense of privilege at meeting in this historic city with its long and great tradition as the center of the arts and sciences. We all recognize that in the field of world energy we stand before tremendous new and pioneering tasks, and it is singularly fitting that we should deliberate about these matters in this now free capital of one of the youngest members of the United Nations. That this fine city should also now have become the likely seat of the proposed International Atomic Energy Agency as a result of the support which my country and other countries are giving to the Austrian invitation is a further demonstration of the new role of this ancient capital."

General Features of Meeting

After the official opening of the Conference at the Vienna State Opera House on Sunday, all the technical sessions were held at the Konzerthaus only a few blocks from the Opera House, and in the center of

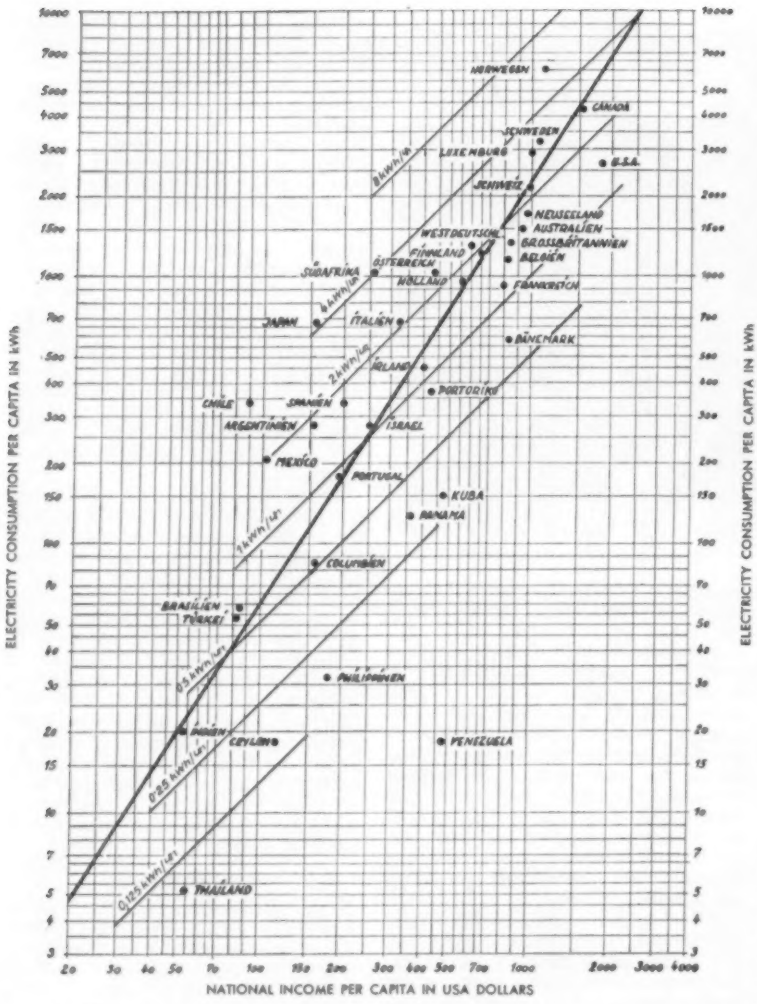


Fig. 5. Shows relation of 1953 electricity consumption and national income

Vienna. It was somewhat of a task to quarter the 3000 delegates in the Vienna hotels and some had to be billeted rather far out. Thanks to the very excellent surface and subway transportation in Vienna, however, members had little difficulty in getting from one place to another.

The general facilities were excellent. There were three large halls in the Konzerthaus in which the technical sessions were held. These were fitted with excellent public address systems with provision for simultaneous interpretation of the addresses. As each delegate entered the hall he was given a small portable radio receiver and a headset which could be plugged into the receiver. This receiver, made by Siemens & Halske, was equipped with a volume control and a three-point switch whereby one could listen to the address in either English, German, or French. The simultaneous interpretation on the whole was excellent — the lag between one language and another was not more than a sentence — a matter of ten seconds taken for translation.

An excellent social program had been planned with concerts, operas, and sightseeing trips available in abundance. A night boat trip on the Danube was especially enjoyable. Included in the program also were inspection trips to the Vienna gas works, the oilfields, the Simmering steam power station of the Wiener Stadtwerke, a transformer plant of the Wiener Stadtwerke, as well as to some of the nearby hydroelectric stations which form a part of the Austrian power system.

The Technical Program

It was, of course, virtually impossible to assimilate the vast quantity of technical material contained in the 300 papers and reports presented at this meeting. Consequently, technical sessions were devoted only to brief discussions of the papers — each discussion being limited in most instances to only 5 minutes.

The papers were classified under five general divisions as follows:

Division I. The Present Status and Development of Power Production and Utilization in Individual Countries.
Division II. The Preparation and Conversion of Fuels.
Division III. Utilization of Primary Sources of Energy.
Division IV. Purification of Waste Water and Exhaust Gas in the Production and Use of Energy.
Division V. International Co-operation in the Production and Use of Energy.

Even a superficial study of the papers presented at the Conference indicated the vast increase in the demand for power throughout the entire world, particularly in Europe and America. Taking the average for Europe, the increase in 1955 was more than 9 per cent over the total electricity consumption in 1954, and in individual countries the rise ranged from 6 to 20 per cent.

According to the statistics of the Federal Load Dispatcher, the increase in the public electricity supply of Austria was no less than 12.8 per cent. Were the increase in electricity consumption to be only 7.2 per cent per annum, power usage would be doubled within a decade.

Experts in the power field as well as in economics have given considerable thought to the question as to the origin of this extraordinary increase in the demand for power and what trends to expect in the future.

In order to arrive at a proper evaluation of the problem a detailed study of this subject was made under the direction of Eric Heller of Innsbruck. This study was presented as a special paper at the Vienna Conference and the results are extremely interesting. In this study it was thought best to eliminate from consideration that portion of the increased demand for electric power which may be fairly attributed to the material increase of the population, a factor which is highly variable in different countries. This was achieved by the simple method of calculating electricity consumption in kilowatt hours on a per capita basis.

The next step was to see if a pattern of relation could be established between per capita electricity usage and per capita material income. Adolpho Dorfmann, a member of the staff of the UNO Economic Commission for Latin America, investigated the relation for 50 countries. Dr. Marcello Rodino further developed this study, and his report is the source of the accompanying diagram showing the relationship between electricity demand and national income in the various countries.

It is interesting to note that in the leading countries, namely Norway, Canada, Sweden and Switzerland, the electricity supply originates almost exclusively from hydroelectric plants. It is also clearly evident from this diagram that there is a certain general relation, even if not entirely

uniform, between these per capita rates. The dots which represent these relations, drawn according to the logarithmic scale, are grouped for the most part close to the heavily drawn line. The conclusion may therefore be reached that a growing national income is accompanied by a rise in the per capita consumption of electricity.

It is clearly brought out in this comparison, and the situation is undoubtedly similar in other European countries, that the increase of electric power consumption by various consumer groups in Austria shows very wide variations. The self-use of electricity by the power industry, as well as consumption by Austrian industry in general, is somewhat above the average increase of 12.8 per cent, while usage by other consumers is correspondingly below.

The great increase of electricity consumption in households in Austria is at least a partial manifestation of the welcome rise in living standards, particularly in the population groups in the lower income strata. In the interval between 1937 and 1955 the number of electric ranges, for example, has increased from about 10,000 to 200,000. This trend may be expected to continue for some time, since at present no more than 10 per cent of all households in Austria cook with electric ranges, while in Germany this figure is already 20 per cent, and in Switzerland 60 per cent.

Fig. 7. The Vienna State Opera House, where formal opening session was held

Atomic Power

AS ALREADY MENTIONED, the subject of atomic power was the topic of greatest interest to the delegates attending the World Power Conference. In view of the increasing demand for electrical energy the world over, and the decreasing supply of fossil fuel resources, nuclear energy offers all the countries of the world a means of meeting adequately the power requirements of the future.

The importance of nuclear energy for the energy supply of the world can best be demonstrated by listing the existing fuel resources. The heat equivalent of all fossil fuel resources is estimated at 2×10^{19} Kcal. The annual consumption figure for 1952 was 2.5×10^{16} Kcal.

The development of nuclear energy is already in full swing, and many types of nuclear reactors for power generation are under construction in various countries of the world. With respect to design principles there are two basic types: In a heterogeneous reactor, solid fuel elements, mostly shaped as rods or tubes, are distributed within the moderator. A coolant flows in channels through this reactor core. In a homogeneous reactor the fuel is mixed with the moderator, i.e. the fuel is dissolved or suspended as fine particles in a liquid; cooling is effected either by circulation of the solution through a heat exchanger outside the reactor vessel or by means of cooling coils in the reactor core.

Far more experience exists in the design and operation of heterogeneous reactors than in that of homogeneous reactors. The power reactors in actual operation or under construction belong, therefore, predominantly to the former group.

The coolant serves for transferring the heat energy liberated and, in the case of a power reactor, for permitting the utilization of the thermal energy. Both liquids and gases may be used as coolants. None of them fulfils all the requirements and therefore compromises have to be made. Cooling with CO_2 gas has all the advantages required except that it has very low thermal capacity. This leads, even if high pressures are adopted, to large cooling systems, high powered blowers, and a limited heat production per unit volume in the reactor.

The power reactor building program started in Great Britain is based essentially on the graphite moderated, CO_2 gas cooled reactor. In spite of the necessary size of the reactor core, containing about 100 tons of natural uranium and 1000 tons of graphite, it is expected that, owing to the relatively low price of these materials, the costs of electricity will be about equal to those from an ordinary power station; i.e. 0.6 d/kwh. A conversion factor of approximately 0.8 is assumed. The CO_2 is compressed for improved heat transfer. Decisive for the adoption of gas cooling for this type of plant was, apart from the possibility of using natural uranium, the excellent safety of the system.

In discussing the British atomic power program, Mr. J. V. Dunworth of Great Britain stated that the first large station in the British program went into operation in May of this year, and that it would shortly be delivering power to the British national power system.

H. H. Gott, also of England, stated that the tests on Calder Hall

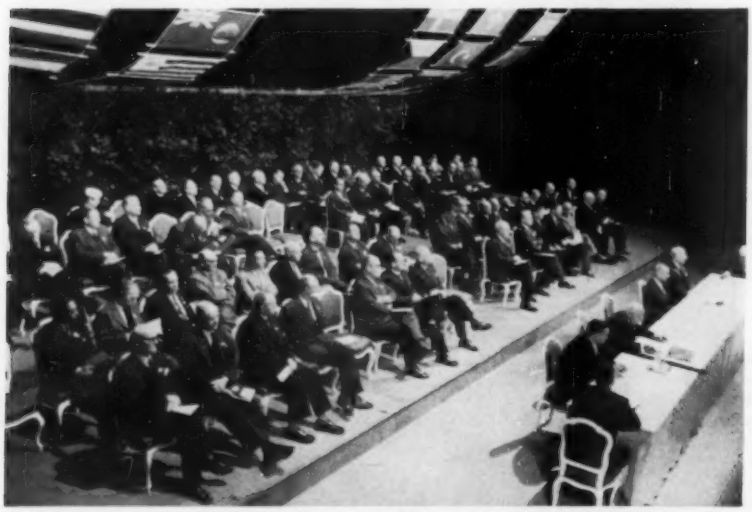


Fig. 6. Speakers and chairmen of Committees at Conference's opening session

Fig. 8. A. T. Hunter, Combustion Engineering, chairman of solid fuels session

have been completed and that the reactor is now fully loaded with uranium. Construction of this station was begun in 1953. It has now been turned over to the operational group and will soon become an integral element in the British power system.

Mr. Gott explained that when the reactor was loaded it was found that the critical size was a little less than had been anticipated. This, however, was an advantage. Also, he pointed out, the Calder Hall reactors are not designed primarily for the production of power. Their primary aim is to produce plutonium — power is a by-product.

In the session on nuclear power, Mr. Gott was followed by Mr. Kasatschovsky of the Soviet Union who briefly outlined the work of the USSR in the nuclear energy field. He stated that the first 5000-kw atomic power station in Russia had gone into operation in 1954 and that the 22nd of June this year will be the second anniversary of the opening of that station. This plant is of the pressurized water type and its operation, he said, has brought out no particular difficulty. The plant has been supplying electric power to the local community and transmission system.

The power costs of the plant are considerably higher than those for large coal-fired power plants, but are comparable to those of small plants. The USSR, Mr. Kasatschovksy said, is currently engaged in the design and construction of some seven different types of reactor plants — some as large as 200 mw.

U. M. Stabler of the U. S. reported briefly on the U. S. Atomic Energy Commission Power Reactor Demonstration program. In addition to the construction of the Shippingport plant and the various reactor designs under way at Argonne National Laboratory, Oak Ridge, and Los Alamos, Mr. Stabler pointed out the important developments in the U. S. in the design of small atomic power plants.

Among these, he mentioned the 22,000-kw boiling water plant to be built at Elk River, Minnesota, and the 10,000-kw homogeneous reactor for the Wolverine Co-operative system near Detroit. This will be the first practical homogeneous reactor plant to be constructed. The development of nuclear power in the U. S., said Mr. Stabler, shows steady progress.

In discussing Sweden's interest in the development of nuclear power, Sture Ekefalk of that country explained that 95 per cent of Sweden's power production is based on water power. For some time now Sweden's power consumption has been increasing at the rate of 6.5 per cent per year. By 1980, all of Sweden's potential water power reserves will be fully developed. So, it is expected that after 1980 all new power generating capacity in Sweden will be nuclear power.

At present, Mr. Ekefalk said Sweden has two atomic power stations in process of design and construction. The first, appropriately named *Adam*, is a 35,000-kw plant, which is expected to be finished in 1960 and the second, named *Eve*, will be a 100,000-kw plant to be completed in 1963. Adam will be heavy water moderated and cooled.

Thermonuclear Reactors

Dr. Hans Thirring, the noted Austrian physicist, spoke briefly on the subject of controlled thermonuclear reactors. As he said, it has been questioned whether all the money and research now going into the design of fission type reactors might not suddenly be rendered obsolete by the discovery of a practical controlled thermonuclear reaction.

Dr. Thirring, however, feels that the possibility of such a development is rather remote. He pointed out that thermonuclear reactions depend not only upon certain minimum temperature — several million degrees — but also upon size. While it may be possible to contain a plasma undergoing thermonuclear reactions in space by means of electromagnetic fields, he felt that the heat release from such systems would be too great for us to design a practical apparatus. He said that in a few millionths of a second the power release in a hydrogen bomb explosion was of the order of 10^{14} kwh.

J. J. West of the Netherlands briefly explained the Dutch atomic power program and spoke in glowing terms of the Eisenhower uranium distribution program.

Commenting further on the British Atomic Power Program, J. C. Duckworth stated that while other considerations concerning future atomic power plants had not yet been decided upon, England had already embarked on large gas-cooled reactor plants for the first step in the program. Atomic power, he explained, was vital in meeting future requirements and he envisaged the time when the entire British power system would be based on nuclear plants.

Mr. Goodlet of Great Britain, in commenting on Mr. Davis' paper (U. S. Atomic Energy Commission), said that he did not agree with Mr. Davis that in the long run only the cost of power will decide whether or not atomic power is possible. In some countries, he said, they may be so energy-poor that there is no alternative.

An interesting development in the application of atomic energy was described by Gosta Lindberg of Sweden. This was a 90-mw reactor which will be used for district heating. The construction of this reactor involves little difficulty since it will operate at a low temperature.

At this session, Titus Le Clair of the Commonwealth Edison Co. of Chicago referred briefly to some new

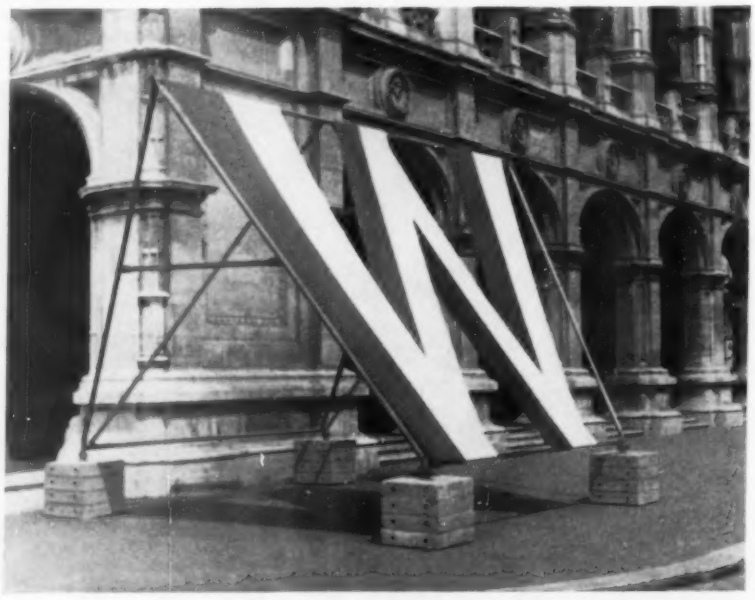


Fig. 9. Large red and white W symbolizes the Fifth World Power Conference

developments in the design of the 180,000-kw atomic plant to be built near Chicago. Estimates indicated that the expected cost of power produced by this plant will be 1 cent per kwh gross, and ¾ cent after subtracting the $15,000,000 research and development cost. Since the original designs were made, he said, new studies have raised the steam pressure from 600 to 1000 psi. This increase in pressure is due to the fact that the fuel elements will be uranium oxide rather than the metallic uranium originally planned.

Another change from the original design, Mr. Le Clair said, was that now only the reactor and secondary steam generator and pumps will be enclosed in the containment sphere. Hence the sphere will be much smaller — only 190 ft in diameter. The turbine generator unit will occupy a separate building outside the sphere.

From this brief account of the character of the discussions it will be apparent that a worldwide interest exists in the subject of atomic power. Many problems remain to be solved but there is little doubt that within another decade practical atomic power development will be well under way.

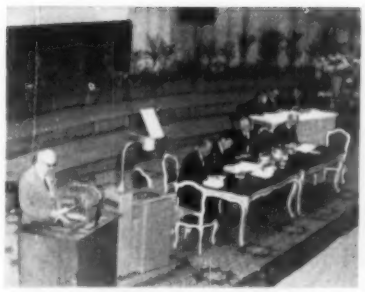


Fig. 10. A view of the stage during one of the conference's technical sessions

Fig. 11. Delegates during the conference meet in lobby, make acquaintances

Hydroelectric Power

ATOMIC POWER casts long and deep shadows on hydroelectric futures. Whether these shadows hide good or evil is a matter which only time will tell. In general, the opinion seems to be that, in the long run, water power will benefit greatly, especially where storage is concerned.

As an example, Switzerland depends almost entirely on hydroelectric power and was a pioneer in this field. At present 16 new dams are under construction. By 1970 it is estimated that the entire hydro potential of the country will be developed. Consequently, additional capacity requirements after that must be supplied from thermal sources.

Atomic power fits well into this picture and might well be the salvation of Switzerland's industrial future. Commercial atomic installations should be available at a competitive price when needed. In fact, there is some optimism that this will be the case earlier than expected.

Such a development in the atomic field might well alter the program materially. As more accessible hydro sites are developed, new projects become increasingly expensive. There is increasing opposition to the loss of land and removal of villages to make storage reservoirs. Early availability of atomic power may well curtail full development of hydro potential.

On the other hand existing hydro developments based on storage facilities are considered a perfect complement for atomic power generation. Atomic energy plants will carry the base load, hydro, the peaks.

Storage, particularly pumped storage, is assuming a steadily increasing place in hydro developments, not only in the mountains but even in the lowlands of northwestern Europe. Hamburg is undertaking a pumped storage project, pumping from a river to an artificial reservoir. Pumps will be operated by power from a steam station utilizing the off-peak capacity.

In general, however, most of the many pumped storage projects are in the mountains and involve relatively high heads. It is interesting to note that of the many projects discussed, Kaplan turbine installations now run up to 226 ft at Bort, France, Francis turbines to 1476 ft at Fronnary, Switzerland, and Pelton turbines up to 5740 ft at Reisseck, Austria.

In size of units, North America maintains the lead in all but one classification. Italy has the largest single jet Pelton wheel, 150,000 hp at Cimego. The largest in other classifications are: Kaplan turbines of 111,000 hp at McNary Dam; Francis turbines at 165,000 hp at Grand Coulee; 4 jet Pelton wheels of 150,000 hp at Kemano in Canada; and storage pumps of 102,000 hp at Hiwassee. The 150,000-kva unit at Stornfors, Sweden, is the largest generator and the output is transmitted at 380 kv. Russia reports turbines on the Volga with a diameter of "no less than 30 ft" and transmission voltages of 400 kv.

Turbine efficiencies continue to increase slowly and now average about 93 per cent for Kaplan, 92 for Francis and 91 per cent for Pelton wheels. Because of the large number of projects considered in more or less detail a further analysis in such a short span is impractical.

For future consideration of an energy source as yet virtually untapped but available in many countries, the tidal power projects undertaken by Electricité de France are worthy of special note. These units consist of a Kaplan turbine driving a generator and set on a nearly horizontal axis.

The turbine and generator form the unit supported in an enlargement in the casing and lying in the water stream. The unit can be operated in either direction and can be used for pumped storage. Installations in the order of 10 to 15 million kw are being discussed. One unit is under test and more exhaustive model tests are being conducted at Grenoble.

Two units of a somewhat similar but slightly different design known as a "tube turbine" have been built. The turbine and generator are set on a horizontal axis, and supported by a spider, lie directly in the flow of water. This design uses a planetary gear which serves the dual purpose of increasing the generator speed so as to decrease the diameter materially and acts as a clutch to protect the generator against the high runaway speed of the Kaplan wheel.

In a discussion of 11 large concrete dams constructed or underway since 1950, it was pointed out significantly that only one has been designed as a mass gravity type. This is the Grande Dixence Dam with a height of 935 ft. The Mauvoisn arch dam is 777 ft. Both of these are said to be the highest structures of their type in the world.

Of other types, in Switzerland the Hirakud Dam, a combined concrete and earth filled dam, has a total crest length of 12.5 miles. In Japan, rock filled dams as high as 492 ft have been built.

On the construction side, the old Grande Coulee record of pouring 380,000 cu yd of concrete a month has been nearly reached at the Grande Dixence Dam. This question of high pouring capacity is of great importance in Switzerland. Because of their reluctance to pour concrete in extremely cold weather, their construction season is limited to about 100 days a year. A practical figure today is considered to be 50,000 cu yd a day, while rock excavation for pressure tunnels in Sweden has reached a record of 1500 cu yd per day.

It is interesting to note that in Sweden, where underground turbine rooms are favored, vertical shafts are not favored; instead, tunnels with a maximum grade of 10 per cent are favored for the transport of equipment and supplies.

While the emphasis was on pumped storage projects, much of the world must place a great deal of emphasis

Fig. 12. St. Stephen's church, heavily damaged during the war, is now repaired

on multi-purpose projects involving all or several functions such as navigation, water supply, irrigation or flood control, and recreation. The TVA, Big Creek, and Colorado projects were cited as different but well-developed multi-purpose projects.

In the new Snowy Mountain Systems in Australia, irrigation is of prime importance. A large reservoir will be constructed below the lowest power generation level to help balance the conflicting needs of power and irrigation.

International Factors

Fortunately or unfortunately, many of the remaining hydro projects in much of Europe involve not only multi-purpose dams but international co-operation and agreement as well. Agreements of this kind are not impossible but are usually involved and difficult. This tends to slow up the development of many promising sites.

At the same time the economic necessity to reach agreement on such projects is a factor that may well be of extreme importance in bringing about better understanding between nations.

The key to international power projects is, of course, transmission across borders. Fortunately there is a long and successful record in this field dating back to the early days of the 20th century when Swiss power was exported to Italy. Today, the whole of central Europe is covered by a grid which can serve as the basis of an integrated network.

Possible international savings were foretold by specific examples. Creation of the British grid in 1938 was said to have reduced necessary space generating capacity in the order of $60,000,000, and cut operating expenses by 17 per cent. In Belgium the difference between the peaks of the individual units and the actual peak of the integrated system is said to be in the order of some 100,000 kw or a capital investment of $12,000,000.

Equally important would be the now concurrent peaks and the shift of load from one section to another without involving long and direct transmission. As an example, the supply of power from Switzerland to the Netherlands was considered as follows: Hydro power from Switzerland would be supplied to Wurtenburg. This would release capacity now used from northwestern Germany and this capacity could then be used for the Netherlands.

International agreements of a broad scope worked out with the comparatively simple problem of electric power might well serve as a precedent for the more complicated problem of water. Agreement between countries sharing waterways as common borders or as owners of portions of the basin is usually involved.

Such international agreements are in effect and the St. Lawrence was mentioned as a recent case concluded after long negotiation. Successful diversion of water from one watershed to another is also fairly common.

However, the boldest suggestion involves grid operation between two networks fed by areas of widely different hydrological characteristics. Runoff of the Eastern Alps and of the coastal district of the Balkan Peninsula toward the Adriatic Sea complement each other.

In summer the runoff of the Alps is at a maximum whereas the flow toward the Adriatic is low. The scanty water flow from the Alps in the winter coincides with ample water discharge from the Dinaric Alps in the autumn, winter and spring. Similar differences exist in other sections.

Carried to its logical conclusion, a district area susceptible to economics and regional development around water power consists of Albania, Austria, Bulgaria, Greece, Hungary, Italy, Roumania, Switzerland, and Yugoslavia. Without geographical unity and with wide differences in resources, culture, and politics, only power possibilities and economics make it a potential unit.

One part of the region has a high per capita consumption of power with a high utilization of potential power resources. The other part has a low consumption and abundant untapped power potential. Part of the region is highly developed industrially with many well known exporters of power equipment. The other section exports only agricultural products, minerals and raw materials.

The strongest economic justification for co-operation between parts of this region lies in the fact that the development and operating programs of the areas do not tally in time and will never lead to identical load characteristics. Consideration of load and runoff characteristics between the sections would materially reduce the necessary investment and at the same time increase the generating and transmission efficiency.

Water Power Resources

In spite of the years of study and volumes of detailed statistics available, the power potential of the world is to a considerable extent still a matter of opinion. Different countries use different methods of calculation and different units so that direct comparisons are difficult to make with any accuracy. This has long been recognized and the problem is now the main concern of Section B, "Methods of Compilation and Use of Statistics in the Production and Utilization of Energy."

The need for this type of standardization is shown by discrepancies between estimates of water power in the world as shown by the accom-

Fig. 13. St. Charles' church in Vienna

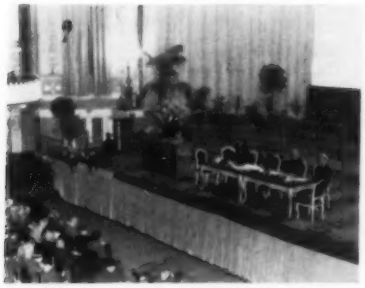


Fig. 14. General view of the stage at the Konzerthaus during the conference

Fig. 15. Entrance to the Konzerthaus, headquarters of Power Conference

panying table. The first column is credited to the U. S. Geological Survey and the second column to the USSR, from what is claimed to be a world survey using a new method of analysis involving both runoff and elevation.

This Congress has done much to complete world statistics which for some decades have been listed as "does not include data on USSR, China and Eastern Europe." The USSR participated actively, and up-to-date statistics cover the intervening period since the Second World Power Conference in Washington two decades ago.

At that time, the survey covered 647 rivers with an estimated potential of 2452 billion kwh per year. A survey completed in 1950 covers 1477 rivers with a gross potential of 2978 billion kwh annually. More than half of this potential is in the Arctic watershed.

To supplement this, Red China presented three papers, liberally sprinkled with praise of the USSR for technical assistance and equipment, outlining multi-purpose projects on the Yellow, Yangtze and other major rivers. Estimates of the power potential on average river flows amounts to 546,000,000 kw.

The first five-year plan, discussed in some detail, calls for adding 2,000,000 kw or doubling the capacities by 1957. The total 1952 capacity is listed as 2,050,000 kw. The survey covers some 107 construction projects which include 92 power stations and 15 transmission line and transformer stations. Of the 92 power stations, "69 are central stations, 22 regional stations and a few railway mobile power plants . . . power plants equipped with 10,000-kw hydro sets and 6000 kw turbo sets, all of Chinese own make, are now in commission" [sic].

Thus, again the World Power Congress has been instrumental in bringing about better understanding between all parties concerned with better utilization of the world's energy resources. As stated in the introduction to the general report:

"By collaboration in the production and use of energy we mean: first, the exchange of energy by interconnection; second, the exchange of experience and knowledge in the field of energy production and utilization; and third, the exploitation of energy resources belonging to several states such as the utilization of water power of rivers forming state boundaries."

Continent or Country	Water Power Resources in hp			
	U.S. Estimates		USSR Estimates	
	Million hp	% of total	Million hp	% of total
Europe	64	10.0	320	6.4
North America	90	14.0	940	18.7
Asia	156	24.2	1795	35.7
South America	62	9.6	804	16.0
Australia	23	3.5	228	4.5
Africa	250	38.7	938	18.7
Total—	645	100.0	5025	100.0
The USSR	—	—	563	11.4

Thermal Plants

CURRENT TENDENCIES in the design and construction of thermal power plants discussed in the 28 papers on the subject reflect two prominent factors governing basic developments:

A. The steady, world-wide increase in energy consumption, continuing unabated since the Fourth World Power Conference in 1950 and leading to the design of new power stations of ever-increasing capacity;

B. The shortage of fuel, especially of boiler coal, forcing efforts to improve the thermal efficiency of power stations.

At present, the major part of the world total of electrical energy production is generated in thermal plants, chiefly of the coal-fired type. Consumption of electrical energy is mounting as a result of increasing industrialization and increases in population.

As a long range estimate, the average world rate of increase in consumption in the civilized world can be assessed at approximately 6 to 7 per cent per year, so that consumption of electricity may be expected to double within a period of about ten years, whereas coal production lags far behind consumers' demand. Increased utilization of high-grade coal for chemical purposes, and rising coal mining costs are responsible for the fact that even now, while world resources still include huge coal reserves, there is a growing interest in energy sources other than boiler coal for the generation of electrical energy.

Within a few decades, the decline in the amount of fuel available for boiler firing will create a grave situation for energy production. Specialists are faced with the task of finding means to ensure suitable power supply, not only in countries with abundant fuel reserves, but also in countries totally lacking or deficient in such basic resources, since importation of coal will soon involve increasing difficulties and costs.

At present, the development of water power resources is still the primary remedy to cure the difficulties arising from the ever-increasing gap between demand for electricity and fuel supply. The potential of the African water power resources alone, the majority of which are still undeveloped, equals the total hydroelectric capacity so far installed throughout the world. But these practically unexploited energy sources are too remote from the load centers, and the problems of economic transmission of correspondingly large blocks of power, for instance by high voltage d-c transmission, are yet unsolved.

In Europe, development of water power resources will be nearly completed in 20 to 30 years. But fuel requirements for thermal power plants will double within ten years. As far as forecasts are possible today, additional demand for electrical energy in Europe at this future date will have to be met exclusively by the construction of new thermal plants.

Although the possibility of utilizing the energy liberated by nuclear fission for the generation of electricity in thermal stations is already indicated, the situation as a whole imperatively demands the development of new methods for the exploitation of conventional energy sources.

Steam Power Plants

In view of the large output usually required from public utility plants, large thermal stations, as a rule, are basically planned as steam power plants, since the maximum output per unit in steam turbines is incomparably higher than in any other heat engine.

New large-scale power plants being built in the United States and Europe nevertheless show considerable difference in design.

In the United States, the total installed capacity in a thermal power plant has already reached the 1,400,000-kw mark while unit capacities in the largest stations total 200 mw, and

Fig. 16. View of the Vienna Parliament

units of 340 mw capacity are under construction. In addition to attaining maximum output per unit of boiler, turbine, and generator, power engineering in the U. S. employs such measures to improve efficiency as:

(a) highest pressures and temperatures,
(b) multiple reheat cycle,
(c) extensive bleed steam heating of feedwater, and,
(d) utilization of highest vacuum.

Highest steam pressures and temperatures before the turbine stop valve so far used in the U. S. amount to 5000 psig and 1200 F.

In Europe, the largest set operating today is rated at 150 mw. Units of 200 mw are under construction. No need has prevailed in Europe, so far, for the construction of power plants of larger capacity, such as are being currently built in the U. S. Reasons for this are to be found in the relative decentralization of power production, resulting partially from the location of collieries, as for instance in the United Kingdom, and in the average per capita consumption in Europe, which is still considerably lower than in the U. S. In Great Britain, however, plans are already under way to erect power stations of 1,000,000-kw capacity comprising five 200 mw units.

Due to the relatively low load factor of the installed capacity of large plants in Europe, the incentive for full utilization of all technical possibilities is naturally not so strong as in the U. S. and they therefore prefer not to increase the steam temperature above 985 F, which permits the use of ferritic steels. Even in Europe, however, individual industrial power plants with high load factors have already operated with turbine inlet temperatures above 1100 F.

Thermal efficiency of steam plants has gone up steadily. At the beginning of the century thermal efficiencies of steam power plants were only 8.6 per cent as against almost 40 per cent now. At the time of the Fourth World Power Conference in 1950, the maximum efficiency of steam power plants had reached about 33.5 per cent. The relative improvement since 1950 amounts to some 19 per cent. This increase is due chiefly to improvement in the operation of the steam cycles — the use of higher pressures and temperatures, multiple reheat, and extensive use of bleed steam for heating the feedwater.

In view of the unfavorable climatic conditions, outdoor construction of steam power plants is rarely used in Europe. Semi-outdoor construction of boiler houses is being used in individual instances, whereas in southern regions of the U. S., outdoor construction is more prevalent. The latter form of construction permits savings of 2.5 to 3 per cent in total plant cost.

Design of Heat-Electric Stations

A noticeable reduction in the consumption of heat for power production can be achieved only by combined production of power and heat. A combined process will allow part or all of the electrical energy output to be generated by back-pressure operation, irrespective of capacity or steam conditions. The thermal efficiency of a back-pressure plant rises to more than 80 per cent.

There has been much more of an effort to use the combined type of heat and power plant in Europe than in the U. S., particularly in the public utility type of plant. Many industrial power plants all over the world, of course, operate on this principle and in the U. S. it is perhaps the principal reason why certain industries generate their own power. In Europe, municipal heat-electric stations are supplying heat energy in the form of hot water or steam. New plants in Czechoslovakia and Poland invariably combine supply of space heating energy with that of industrial steam, while co-operating in a power distribution system with hydroelectric and condensing power plants.

The advantages of gas turbine plants lie in their short start-up and shut-down times, and in their practical independence of cooling water resources, and in the high degree of effective heat utilization even in small units, approximating the rate obtained in large-scale power plants. At present, a wider use of gas turbines in public utility stations is prevented by the limitation of output per unit to a current maximum which is about 30 mw.

Gas turbines, however, have already gained ground in public utility power systems for purposes of supplying peak load requirements. The largest gas turbine plant so far is an open cycle double-shaft unit of 27 mw capacity constructed by Brown-Boveri at the Balzru station of Nordost-Schweizerische Kraftwerke AG. The unit uses heavy oil with a vanadium content requiring a limitation of temperature to about 1200 F. There is, however, reason to expect that the increase of output per unit beyond the present limit of 30 mw will be possible.

Combination Gas and Steam

The combination of gas turbine and steam power plants is aimed at increasing the thermal efficiency of the plant as a whole. The basic idea has been borrowed from the well-known mercury steam process. The problems encountered in the practical application of the mercury-steam cycle were many and often expensive to solve. Hence interest in the mercury-steam cycle has waned, and more interest is being displayed in the more practical gas turbine-steam turbine cycle.

For practical purposes it can be considered that today's proposal for a combination gas and steam turbine plant was anticipated in the design of Brown Boveri's Velox boiler. This unit provides the combustion chamber of the steam generator to be supercharged by a gas turbine com-

Fig. 17. The Konzerthaus where the World Power Conference sessions were held

pressor, with the steam plant remaining the primary element. In comparison with steam turbine output, the boiler waste gases utilized for the drive of the gas turbine are yielding only a slight surplus output in the gas turbine stage.

Various possibilities for combining gas and steam turbines mentioned in papers submitted by France, Czechoslovakia, Austria, and the U. S. at the World Power Conference prove that the idea of increasing efficiency by methods of combination has already received wide attention.

Among other combination schemes considered to improve further the efficiency of thermal power stations was the use of the gas turbine with free-piston engines. This scheme has already gained ground in France, where gas turbines serve as prime movers for ships, locomotives, pumping stations. As shown by the Cherbourg power station, consisting of eight such units with a total capacity of between 6000 and 69000 kw, this combination may also be employed in electricity supply to operate peak load plants.

Fig. 18. Map of the Austrian electric power system displayed in the Konzerthaus

Fuels—Preparation and Conversion

PAPERS and discussions dealing with the subject of fuels at the Conference could roughly be divided into three broad categories. First was the consideration of solid fuels and their preparation. Second were the papers dealing with the liquefaction of solid fuels and the preparation of liquid fuels. The third category concerned the application of statistical methods to fuel and power economics.

The highly complex subject of coal preparation and conversion has so many ramifications that at the session on solid fuels it was necessary to confine discussion largely to the mechanical preparation of solid fuels such as bituminous and brown coal.

The multiplicity of methods of preparation and utilization is equalled only by the multiplicity of types of coal. A simplification has been made by the Coal Classification Working Party of the Coal Committee of the European Economic Missions.

The coal classification system suggested at Geneva in 1952 is based on the content of volatile matter, on the agglutinating power, and the caking capacity. This system has been set up on the pattern of a system of coal classification used in Great Britain. As under the English system, types of coal are specified by three-digit code numbers. These index figures have proved far more reliable in specifying a certain genetic or technological type of coal than have the proper names hitherto used in various countries.

As usual the basic classification is made in accordance with the content of volatile matter. Ten grades are established ranging from 0 to 9. The first digit in the code number refers to the class in which the type of coal concerned must be included. Thus, if the code number begins with 9, the coal in question is highly volatile.

The second figure of the code number supplies information on the swelling index of the coal. There are four groups of swelling indices, 0 to 3. The group marked 0 comprises coal types with a swelling index of between 0 and 0.5, that is, non-caking and non-swelling coal. Coals with strong caking and swelling properties, covered by swelling indices 4.5 to 9, are characterized by figure 3.

The third figure of the code number supplies information on the caking power. This scale has 6 subdivisions (from 0–5) which correspond to 6 different degrees of caking.

Apart from the classification briefly described above, a uniform system of classification for commercial coal is also contemplated. This would constitute a desirable specification since the exchange of varieties of coal among nations is steadily increasing.

Solid Fuel Problems

At the first session on fuels, the general reporter gave a short survey of various problems arising out of the 12 papers presented under the section on solid fuels. Although nothing new was presented where the processing technique of preparation was concerned, the discussion confirmed the trend to increased mechanization in the mining of coal in various countries. This increased use of mechanized methods has brought about increased deterioration of raw coal and some of the discussion was concerned with what measures might be taken to avoid such deterioration.

Lecutier and Loison, of the French delegation, discussed the Longway-Burstline process, the latter giving some remarkable information about the success achieved by preliminary drying of the caking coal. J. P. Graham of Great Britain dealt with the caking of mixtures of coal as means for widening the range of coals suitable for caking and with the work done in this sphere in Britain.

The extent of the efforts made in Great Britain in this respect could be gathered from the speech of Mr. Bonovsky who reported on very interesting investigations into the reaction heat in caking. The fact that, in spite of the great number of methods under investigation in Great Britain all efforts are co-ordinated, was clearly shown by the speech of G. W. Lee. His explanation also touched upon briquetting, which was subsequently dealt with in a remarkable way by Raymond Chéradame of the Bureau of Mines in France.

Apart from processing problems, mining questions also were discussed. Mr. Bogomolov gave very interesting information about coal mining in the Soviet Union, which produced 391,000,000 tons in 1955, and about their efforts to increase this figure to 593,000,000 tons in 1960.

In reply to a question by van den Heuvel, Alfred Wimmelmann of Essen, Germany, informed the meeting that for technical reasons an underground gasification system for the utilization of non-extractable coal deposits would be out of the question for the Ruhr District.

Liquid Fuels

The session on Liquefaction of Solid Fuels was presided over by Arthur T. Hunter, vice president of the Conference and of Combustion Engineering Co. in New York.

In his opening speech, general reporter Prof. Hans Poll of Vienna first reviewed briefly all the papers submitted.

Fig. 19. POWER ENGINEERING'S representatives at WPC. Editor A. W. Kramer (left) and Editorial Director R. H. Morris, before transmission line map

In opposition to the General Report, Dr. Michael Freund of the Hungarian Petroleum and Natural Gas Research Institute advanced the opinion that in the future diesel oils of high sulphur content should not be refined by means of expensive hydrogenating desulphurization processes. In view of the cost factor, he proposed the much cheaper elimination of the reactive sulphur compounds by appropriate admixtures of additives to the lubricating oil. Correctly proportioned admixtures of additives to lubricating oils permits the use of diesel oils with a sulphur content of up to one per cent without damaging the engine.

Among the speakers from the U. S. at this session was Henry Ogarzaly of the Esso Research and Engineering Co., who explained the efforts taken to exploit the large scale oil-shale deposits in the states of Colorado, Utah, and Wyoming for commercial and technical purposes. The shale oil resources so far proved are estimated at 200,000,000 barrels — a sufficient quantity to cover the country's demand for 50 years.

The Bureau of Mines, he said, has set up a special committee to make thorough studies of the complex problem of shale oil upgrading and to ascertain all possibilities of utilization. The production of fuels from oil shale is more economical than that from a coal base, but the fuels recovered are of substantially higher cost than normal petroleum products.

The speaker finally stressed that large deposits of tar sand occurring in western Canada, especially in the Athabaska River area, also warrant exploitation. He added, however, that upgrading methods could not be the same as those employed in processing oil shale.

Another report on the utilization of oil shale was made by Chase Pad-Lean of China and Mr. Bolubzove of the Soviet Union. It is interesting to observe that even now both sides of the Western and Eastern worlds are taking up the problem of making more use of oil shale and shale oils to produce energy. While in the United States the reason for such plans is the desire to guarantee future sources of supply, the motive behind projects in Estonia and the Leningrad District is absence there of oil resources.

In her efforts to ensure an output of high-grade products, China is studying and employing the established processes of hydrogenation, selective refining, catalytic cracking and catalytic reforming, partially modifying the original methods. The Soviet Union is mainly concentrating on producing heavy and light gases, shale petrol, gas oil, shale tar oil, bitumen and other chemical products including phenol. In the process of coal carbonization, the Soviet Union employs continuous-type chamber and tunnel furnaces.

Albert Parker of Great Britain pointed out that the crude oil supply of the world is facing ever rising difficulties, with steadily increasing costs of prospecting. Despite this situation, the speaker maintained that the cost of crude oil, produced at such expenditures, is still much below the cost of shale-oil upgrading, let alone coal hydrogenation. Whenever supply should be forced by one reason or another to rely on synthetic petrol, only the modified Fischer-Tropsch process (gas synthesis) could be considered a suitable means to keep world market fuel prices at a tolerably normal level. For this reason, British science devotes its main efforts to producing water gas cheaply.

Must We Hoard Oil Resources?

Bela Zentay of Hungary discussed the question of whether it would not be advisable, in order to save crude oil, to promote the utilization of industrial waste products for heating purposes.

Arnold Reiners of Standard Oil (N. J.) thought that the crude oil shortage was not a really critical factor, since, according to his expectations, atomic energy will already cover an essential part of the world power supply in the course of the next two decades. Mr. Reiners went on to say that he believed that the petroleum deposits at present known, and consequently the reserves estimated therefrom, do not truly reflect the actual situation, since the estimates used to form the final picture only take the reserves into account. In reality, he declared, the problem does not warrant an over-pessimistic attitude, for experience has shown that the more oil is discovered, the more reserves can be hoped for.

Diesel vs Spark Ignition

The question "Why do the United States and Japan prefer to use petrol engines of the spark-ignition type in motor vehicles" was discussed at considerable length by various speakers. From this discussion it seemed evident that users in U. S. and Japan prefer ignition engines because of the relatively low cost of gasoline in those countries; in Western Europe, and principally in Germany and Austria, diesel engines are used for heavy duty transport vehicles, and recently, also for passenger cars. Despite the higher cost of the diesel engine vehicles, their advantage lies in lower fuel cost and quicker amortization of the investment.

Fifth World Power Conference Papers

PAPERS referred to in the present report were preprinted and a complete set of them in English, French and German was sent to each engineer who registered to attend the conference in Vienna, Austria, June 17 to 23. At the present time, no other copies of the individual papers can be obtained, but they will all be issued in several bound volumes as the Transactions of the World Power Conference. These will probably not be available until some time in the spring of 1957.

Readers who wish to place an advance order for a complete set of these Transactions, which will cost in the neighborhood of $50 or $55, should communicate with the U. S. National Committee, World Power Conference, 29 W. 39th St., New York 18, N. Y., attenion of General Stewart E. Reimel, Secretary. Central office of the World Power Conference is at 201–2 Grand Buildings, Trafalgar Square, London, W.C.2, England.

In the meantime, readers interested in looking at copies of the individual papers are welcome to examine the complete set we have here in our office. Also, there are two complete sets in the office of the National Committee in New York City, at the above address, and the Secretary states that anyone interested may examine the individual papers there also.

Finally, we have a mimeographed list of only those papers that were printed in English, about 150 papers. If you want a copy of it, write the Editor, or jot WPC LIST on the return postcard elsewhere in this issue.

Editor's Note:—How does the "Great Fluoridation Scare," now sweeping the country, affect the power engineer?

Many readers have asked: "Our city is going to fluoridate the public water supply, and that water is our source of boiler feed make-up. How will the addition of 1 ppm of fluoride (the amount recommended for dental protection), to our feedwater, affect our water treatment methods and our boiler water and our steam?" To help answer this question, Professor Straub, well-known in the boiler water treatment field, gives some specific data resulting from his work.

His general conclusions: In boilers operating up to about 800 psi, soluble fluorides have no appreciable effects; for boilers at 1400 psi or more, they should be carefully checked.

How Does Fluoride Act in Steam Boilers?

By F. G. STRAUB

BRIEF SURVEY of the literature relative to the use or the action of fluorides in steam boilers indicates that sodium fluoride was in use as early as 1889. C. A. Doremus obtained U. S. Patent No. 404,180, May 28, 1889, covering the use of sodium fluoride for purifying water. He published several papers in regard to the use of fluorides for softening hard waters as well as the use in boiler feedwater to prevent scale formation. (*J. Amer. Chem. Soc.* 12,203; 1890; 15,610; 1893).

This writer studied the solubility of calcium fluoride in synthetic boiler waters in the pressure range from 150 to 1000 psi. (*Bulletin No. 283*, Engineering Experiment Station, University of Illinois, 1936, pp 45–50). The following is a summary of that work.

1. Calcium fluoride is less soluble than calcium sulfate, and more soluble than calcium carbonate or phosphate, at the temperatures studied.

2. The presence of 50 ppm of sodium fluoride in solution should prevent the formation of calcium sulfate at temperatures up to 470-F even when the sodium sulfate content is around 2000 ppm.

3. The presence of aluminate in solution aids in the precipitation of the calcium fluoride.

Methods of Reducing Fluoride

These results indicate that when a boiler water has soluble sodium carbonate or phosphate present the fluoride would remain in solution in the boiler water. The fluoride would be in solution in the feedwater when untreated water containing fluoride is used for makeup. Normally a cold-lime softening might not remove the fluoride. Likewise sodium zeolite softening will leave the fluoride in the effluent.

When the make-up water is evaporated or demineralized the fluoride would be practically all removed from the makeup water. With low fluorides in the feed to an evaporator, the evaporator vapors would be free from fluoride. The fluoride must also be removed in the anion bed of a demineralized unit. This would reduce the possibility of appreciable amounts of fluoride being present in higher-pressure boilers using these types of make-up water.

When the use of resins for removal of soluble anions from water was in the development stage, the weak base anion resins then available would not remove the silica present in the water. One method that was suggested to reduce the silica was to add fluoride to the water ahead of or in the hydrogen cation bed. This would convert the fluoride to hydrofluoric acid, which would form fluosilicic acid with the silica. The weak base anion resin would remove the fluosilicic acid. There was a possibility of some fluoride passing through the anion bed.

Results of Studies

In 1946 studies were conducted at the University of Illinois to determine the effect of soluble fluoride in boiler water on the resulting steam. Sodium fluoride was added along with other chemicals such as sodium hydroxide, phosphate and chloride to a small steaming boiler in the laboratory and the effect on the resulting steam determined. The accompanying table gives a summary of the data collected at that time.

These results indicate that at 700 psi, with 62 ppm NaF in the boiler water, the effect on the steam was not detectable. When the steam pressure was increased to 1600 psi, the fluoride has an appreciable effect on the steam. As the fluoride content of the boiler water increased, the steam specific conductance increased and the pH value decreased with an increase in the fluoride in the steam. This indicated that the fluoride was vaporizing apparently as hydrofluoric acid.

Shortly after these tests were conducted, the strong base anion resins capable of removing the soluble silica in the water without the need for fluoride became available.

Based on the material presented, the following conclusions may be reached:

1. If fluoride is present in the feedwater it can concentrate in the boiler water.

2. The soluble fluoride in the boiler water in boilers operating up to around 800 psi should not have any appreciable effect on the steam.

3. Boilers operating at 1400 psi or higher should be checked to determine the effect of any fluoride in the boiler water on the resulting steam.

Summary of the data obtained by Professor Straub during his tests for fluorides

	BOILER WATER					STEAM	
	ppm						
Steam pressure psi.	NaF	NaCl	Po4	pH	Sp. Cond.*	pH	F ppm
700	0	10	——	10.95	0.34	6.6	0.00
700	62	10	——	10.95	0.34	6.4	0.00
1600	1	0	0	10.25	0.34	6.8	0.00
1600	9	0	0	10.25	1.15	5.65	0.05
1600	11	0	0	10.35	1.05	5.75	0.05
1600	15	0	0	10.65	1.05	5.75	0.05
1600	27	0	0	10.80	1.00	5.70	0.05
1600	44	14	0	10.60	1.70	5.60	0.10
1600	50	0	0	10.85	1.85	5.38	0.10
1600	80	0	0	11.10	1.90	5.35	0.10
1600	80	0	54	10.90	2.10	5.30	0.10
1600	80	0	110	10.6	2.10	5.30	0.10

*Sp. Cond. = specific conductance

Research Professor, Chemical Engineering, University of Illinois

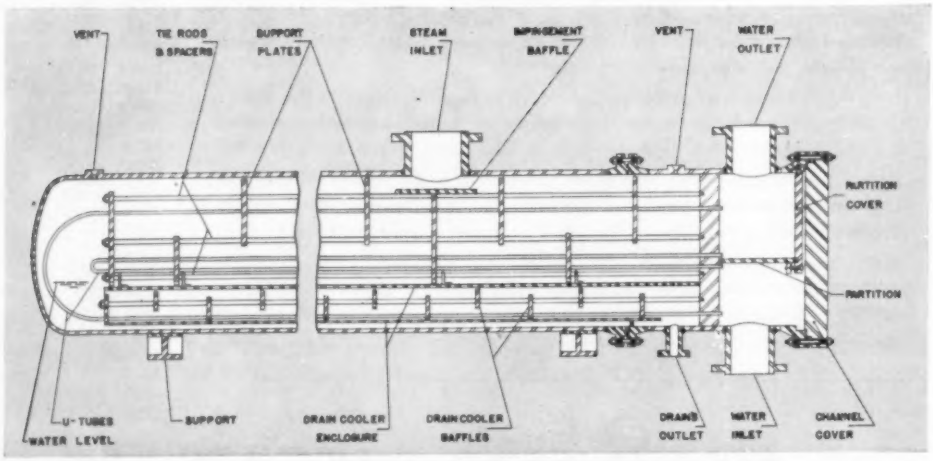


Fig. 1. Section through a horizontal low-pressure type closed feedwater heater with a drain cooler

Take a New Look at the Extraction Heater

The author has drawn on his long experience with heat exchanger equipment to describe various ways in which commonly neglected losses can be reduced and heating cycle efficiencies increased

By JOHN M. DRABELLE, M.E., E.E.

CLOSE OF World War I saw the various industrial and utility power supply systems of this country faced with higher fuel costs and a tremendously increasing demand for power. As a result, certain changes of a historical character which will be recited briefly came into this development.

There were necessarily many divergent views among the engineering profession as to the application of the regenerative cycle, the number of heaters, and the various bleed and pressure points at which steam should be extracted from the turbine. The turbine manufacturers were, of course, confronted with a situation where practically every turbine order meant a change of patterns in the shop to meet the various ideas on which pressure and from which stage this steam extraction should be taken for the various heaters; likewise the number of heaters employed in the cycle varied tremendously.

This confusion resulted in delays and very expensive shop and design changes, so standardization of such values as the number of openings and the pressure points naturally followed. This brought about the standardization of large steam turbines which was the joint work of the American Institute of Electrical Engineers and the American Society of Mechanical Engineers that led to the preferred turbine standards of today.

This standardization has benefited the entire industry by the elimination of many unusual and freak arrangements, a reduction in manufacturing time of turbines and has acted to prevent runaway prices due to the elimination of design and shop changes in machines.

In line with the trend to eliminate every source of heat loss, however small, low head heat such as may be recovered from the generator losses should be given serious consideration in the cycle as this heat should go to the condensate and not to the river.

The modern high temperature high pressure unit of today operates approximately 8,000 hours per year. The down time of these units for inspection, cleaning and insurance purposes is approximately two to three weeks per year. Hence, with the long hour operation and essentially base load operation, the recovery of low-head heat at the present cost per million Btu is of substantial dollar advantage in the operation of the station.

These units with the exception of the 12,500-kw unit are all hydrogen-cooled and even the small units being air cooled are equipped with surface coolers in the generator, and water is required from some source to remove this heat produced by the generator losses. Hence, condensate may be used instead of house service water for this generator cooling and this accumulated heat may be passed

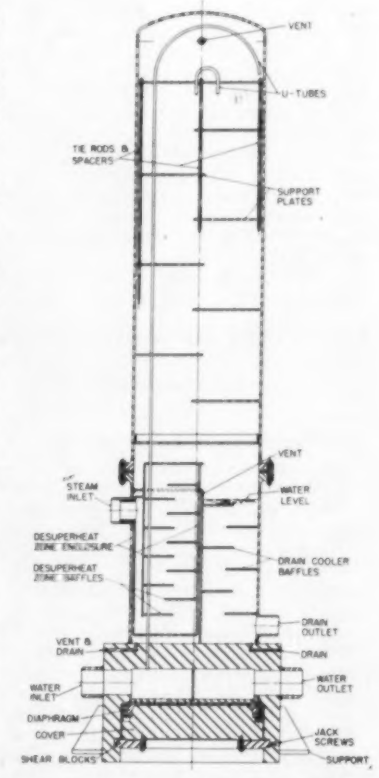


Fig. 2. Section through vertical high pressure type closed feedwater heater

to the cycle instead of being washed. Take for example a 16,500-kw. hydrogen-cooled machine, which has a recoverable loss per hour of approximately one million btu. at capability. When this is considered on an annual basis of 8,000 hours and say thirty to forty cents per million Btu., then this heat recovery has definite dollar possibilities.

Due to the elevation of condensate temperatures in the summer time above the ninety-five degree limitation of generator coolers, a small heat exchanger of the water to water type may be used to depress the condensate temperature to whatever the coolers are designed for, namely, the ninety or the ninety-five degree standard.

By admitting cold water from some source to this water to water heat exchanger, then for a relatively few hours per year this temperature may be depressed to whatever the limitations of the generator coolers may be and at a very small cost as the number of hours of condensate depression are relatively few as compared to the total annual operating hours. This water may further be automatically controlled by some type of temperature operated valve.

Dependent upon turbine size and classification the usual arrangement of feed water heaters consists of two or more heaters, the low heater being located close to the condenser and operating usually at a pressure of approximately ten pounds absolute. The next higher heater is usually that of the open or deareating type and of the direct contact, zero terminal difference type where the elimination of oxygen and carbon dioxide from the boiler feed water can readily and easily take place. And then, again, dependent upon turbine size, pressure and other factors, two or more heaters of the higher temperature classification are installed.

There have been in this country a limited number of applications of the direct contact type of heater with zero terminal difference from the condenser to the boiler feed water line. The usual arrangement, however, is that with the exception of the deareating heater, these heaters are of the closed or tube type.

Closed type heaters are available in two types, the horizontal and the vertical (see Figures 1, 2 and 3). The vertical is now coming into more and more use for several reasons and these are: — they can be installed very close to the turbine keeping the run of piping between the extraction flange and the flange on the heater to the absolute minimum, thus saving a considerable amount of money and pressure drop. This arrangement has the further advantage that they can be handled by the station crane for both installation and later for inspection purposes of pulling the tube bundle from the heater shell. There is a further advantage with the vertical arrangement: all valves, both water and steam, are installed alongside the heater on the operating floor, thus eliminating many steps for the operating personnel of the station.

For the purpose of this discussion, the numbering of extraction openings begins with #1 opening, this being the opening nearest to the turbine throttle and admission gear and numbered usually to numbers #4, #5, or #7 toward the condenser. The heaters are numbered in an ascending order beginning with either #1 at the point nearest to the condenser and numbered in ascending order to opening #1 of the turbine extraction flange adjacent to the steam admission to the turbine.

An examination of the Mollier diagram will, of course, show that the steam extracted at extraction point #1 has done comparatively little work, or, stated another way, might have a steam rate of say 40 lb per kilowatt hour and the steam extracted at the lowest extraction flange, say #4 or #5, may have a steam rate of 10 lb or 15 lb per kilowatt hour, consequently the steam extracted at the first extraction flange will show a very considerable amount of superheat *continued on page 118*

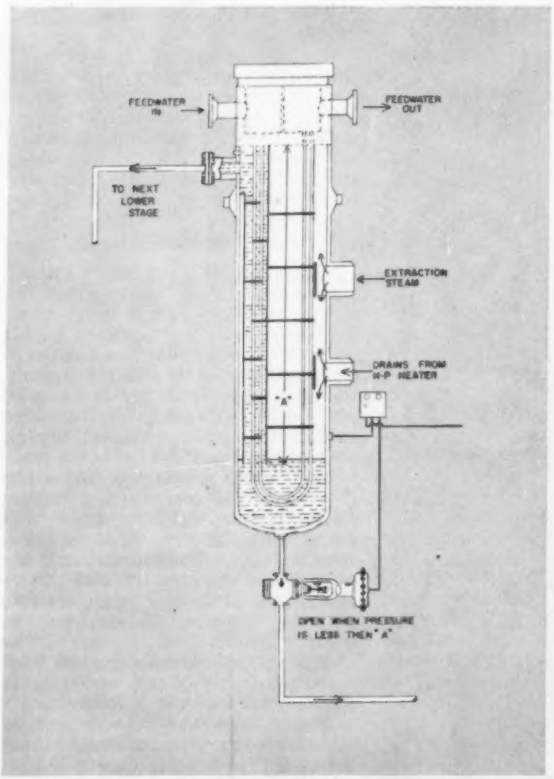


Fig. 3. Shows use of pressure-actuated valve to change from bottom drain to regular arrangement using condensed steam

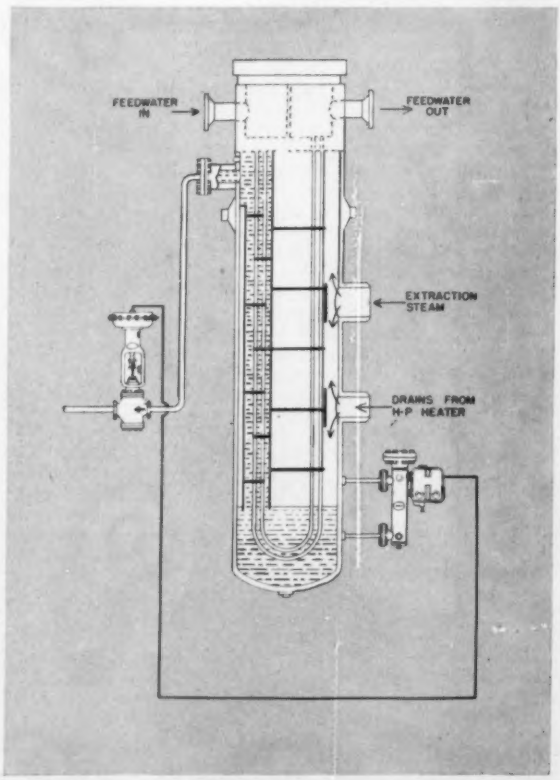


Fig. 4. Use of pressure-operated valve to maintain an adequate level of condensed steam in the cooling zone of heater

Can the Low Pressure Turbine

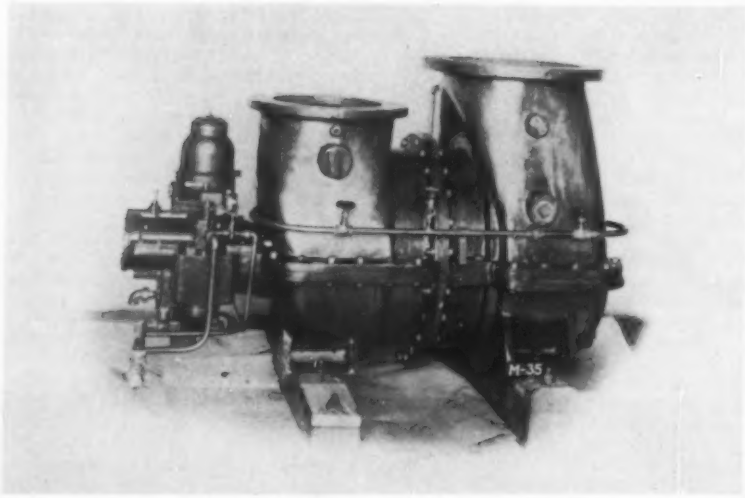


Fig. 1. 238 hp low pressure turbine. Inlet pressure 18 in. Hg. Exhaust 27 in. Hg

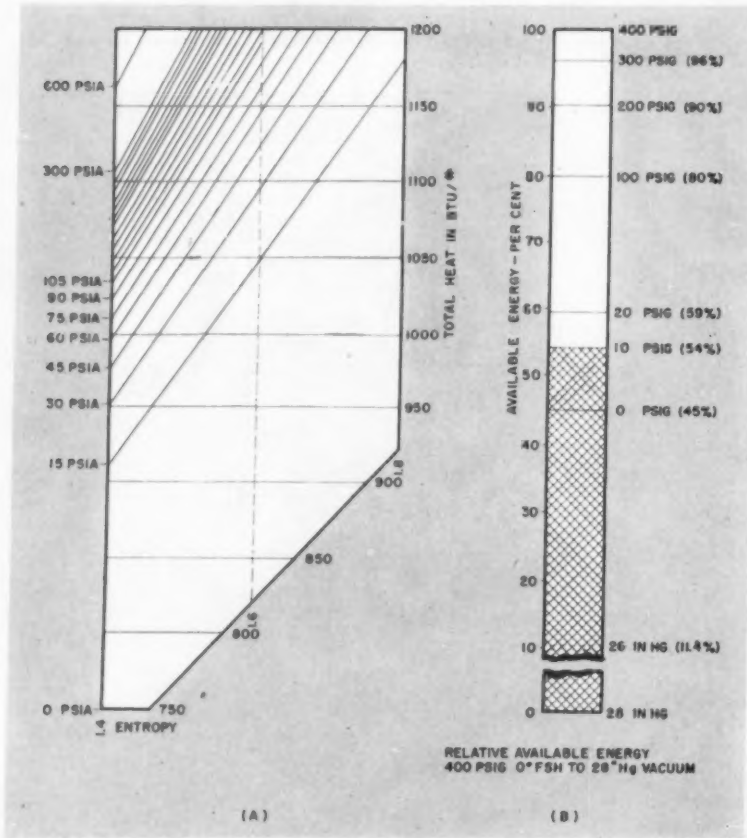


Fig. 2. Part of Mollier diagram showing the large amount of energy available in low pressure steam. Note that steam possesses more potential work between the pressures of 10 psig and 2 in. Hg than between the pressures of 400 and 10 psig

By JAY R. GINDER *

BY DEFINITION, a low-pressure steam turbine is a unit designed to operate with inlet pressures of 20 psig or less. Although practical limitations dictate that these machines exhaust to a vacuum, inlet pressure need not be limited to a positive value (above atmospheric). Fig. 1, for example, shows a turbine which takes inlet steam at 18½ in. Hg vacuum and exhausts at 27½ in. Hg.

This application is often overlooked through lack of appreciation of the tremendous energy available in steam throughout the low pressure region. The familiar Mollier diagram, reproduced in part in Fig. 2, displays the basic thermodynamics involved. Note that for equal pressure increments, vertical distances between constant pressure lines rapidly increase as one descends the pressure scale.

This same phenomenon is shown more directly in Fig. 2 which depicts graphically relative available energy between various pressures. It is interesting to note that a pound of steam possesses more potential work between the pressures of 10 psig and 2 in. Hg than it does between 400 and 10 psig.

Therefore, if each of these pressure differentials were to represent inlet and exhaust conditions on two different turbines, one could expect equal output from either machine for identical steam flows. This, of course, assumes similar efficiencies for both applications, which is often the case.

Application

To eliminate confusion which sometimes exists concerning the terms "efficiency" and "steam rate" it may be well to define each at this point. The steam rate of a turbine is the indication of its steam consumption, expressed in lb per hp-hr or lb per kw hr. Efficiency on the other hand is simply a ratio of energy utilized to energy available.

This differentiation is important if one is to properly evaluate performance of the low pressure machine. Occasionally these applications are unjustly discarded as being inefficient when actually, with proper evaluation of energy chargeable to the unit, machine efficiency may be quite favorable.

The low pressure turbine has justified itself in many and varied applications, a few of which follow:

Many large buildings or institutions have low pressure steam boilers primarily for heating during winter.

*Steam Turbine Division, Worthington Corporation

Save You Money?

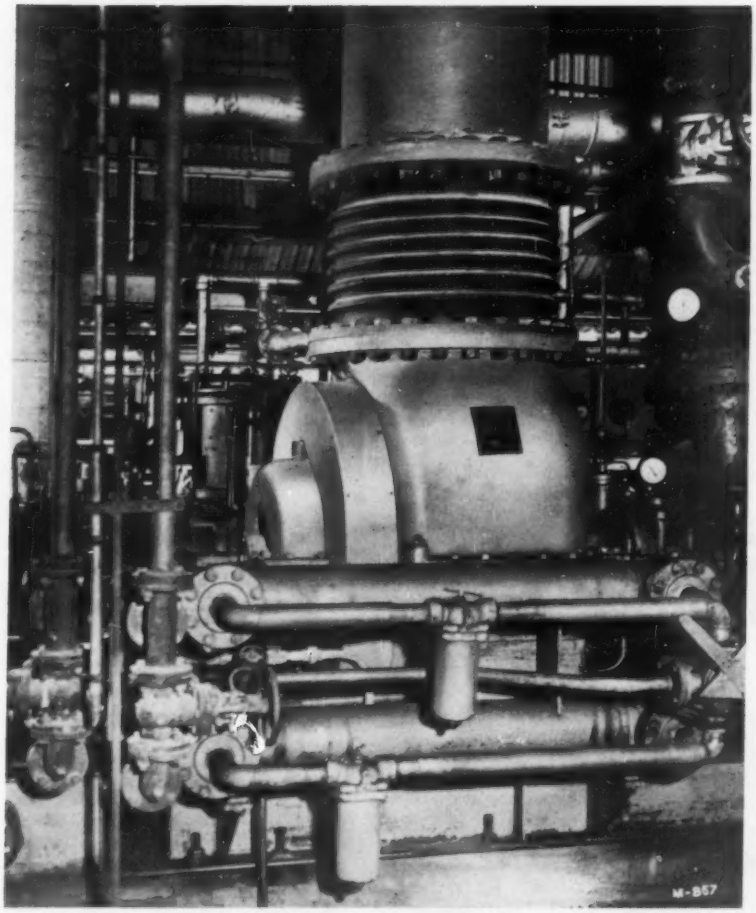


Fig. 3. A 1760 hp 1-p turbine 8000 rpm. Inlet pressure 15 psi. Exhaust 26 in. Hg

In such cases, investigation of a low pressure turbine for driving air conditioning compressors may uncover significant benefits. For moderate and low cost fuel areas, steam generating charges for operating the unit will usually be less than comparable power costs for a different kind of drive. Then too, the improved load factor brought about by year-round operation has a marked effect on fuel demand, labor, and capital investment charges. This unit might also consume previously wasted or inefficiently utilized low pressure steam from other non-condensing equipment.

Industries sometimes find themselves with numerous pumps and compressors in widely scattered locations. In this situation, steam piping costs must of course be minimized. Such a condition therefore lends itself to utilization of small non-condensing turbine drivers with exhaust steam being collected as throttle flow for a low pressure condensing unit, thereby permitting reclamation of condensate.

The author was recently involved in an interesting corollary of such an arrangement wherein an oil refinery wished to utilize electric drivers on the majority of pumps with turbine driven standby equipment for the critical applications. This necessitated installation of a boiler strictly for emergency service. By use of a low pressure turbine for the largest piece of critical equipment, the size of the emergency boiler was reduced by almost 50 per cent under the size that would have been required had all standby turbines exhausted to atmosphere.

At times station heat balance changes will be such that demand for exhaust steam from existing non-condensing equipment may be diminished or eliminated entirely. Usually, conversion of a back pressure machine for efficient condensing operation is not economically feasible.

However, the addition of a low pressure turbine to the system could possibly be the answer. This could be accomplished either by double extending the shaft of the driven machine to receive the second driver or by installation of a second driven machine for connection to the low pressure turbine. In either case, the effect is that of the condensing extraction machine in two separate casings.

A recent study of an institutional power station provides an interesting example of the above. The establishment had previously installed a non-condensing turbine generator to supply exhaust steam for building heating. Experience proved this arrangement less than satisfactory, however, since the unfavorable load factor boosted supplementary purchased power rates and resulted in inefficient utilization of invested capital.

Calculations revealed that a low pressure unit could be installed to collect all exhaust steam during the summer months and excess steam during the spring and fall. It is also significant that with installation of the low pressure unit capacity of the station will be exactly doubled.

Construction

Basic design features of the type machines under discussion are identical to those of a conventional unit. As one would suspect, however, such a unit is characterized by an oversize high pressure section to permit handling of inlet steam with large specific volumes. The standard and conventional single stage turbine will develop up to approximately 150 hp with 20 psig inlet steam and 26 in. Hg vacuum exhaust. For greater power requirements or for maximum efficiency one would probably select the multistage unit with its almost unlimited combination of inlet and exhaust openings.

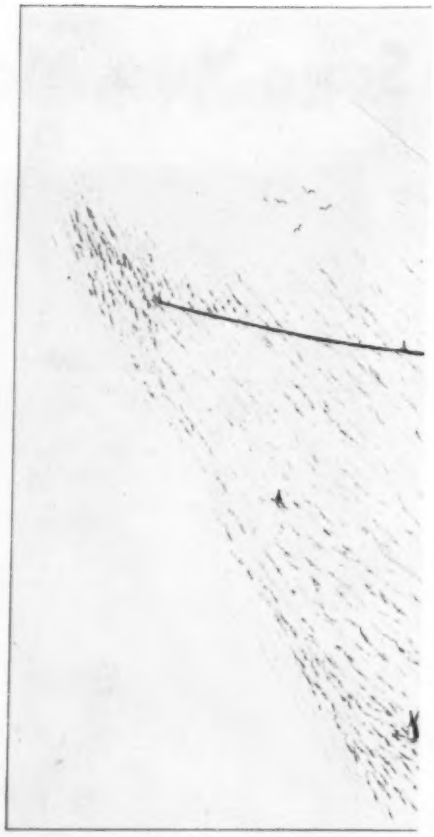
Construction of larger low pressure machines can often be simplified by converting the exhaust end of a conventional unit for use as an inlet section of the low pressure turbine.

Cost

The information given in the preceeding paragraph indicates that when steam flows are within limitations of conventional turbines there will be no increase in cost for the low-pressure machine. For larger sizes, the enlarged steam end will usually increase cost of construction, but seldom in excess of 15–20 per cent. It is understood, of course, that the costs include those of condenser, auxiliaries and necessary piping.

Other examples of performance and cost data, from specific existing installations, will be presented by the author in a future article.

Fig. 1. Conception of a wave power station designed to utilize artificially-induced resonance, or "seiching", of normal wave motion to compress air in port →



EDITOR'S NOTE

Schemes for extracting new forms of energy from nature come forward with persistent regularity. Some may even achieve a brief flurry of publicity before sinking into oblivion, but almost all such schemes eventually come to nothing either because the method of converting the available low-grade energy into useful high-grade energy is completely impractical or because it is too costly in terms of the energy readily available from established sources.

In the following article, a method is proposed by which the wave energy of the oceans might be harnessed. That this proposal does not fall into the category of blue-sky day-dreaming is made evident by the fact that it is now a subject of serious study by one of the most competent business research groups in the country. Although there are many hurdles — known and unknown — yet to be overcome, none of these appear to be insurmountable. Experimental laboratory results are sufficiently encouraging to warrant extension of the work.

Readers who are interested in the complete thesis describing the original work at MIT that led to this study may obtain a copy by writing to the author: *Edgar E. Jacobs, Wave Power Project, Arthur D. Little, Inc., 30 Memorial Drive, Cambridge 42, Mass.*

Power From Ocean Waves —Another Energy Source?

By EDGAR E. JACOBS*

THE LIMITLESS ENERGY of the ocean has long challenged man's ingenuity; the pounding of the surf and regularity of tides have inspired numerous schemes to utilize these forces. Gravity waves, the type caused by wind acting on the ocean surface, may be only a few feet high and yet develop as much as 50 kw of power per foot of wave front. Thus a thousand-foot wave-front could develop as much power as a small electric-power plant (50,000 kw).

To harness this energy, however, involves a number of technical and economic problems. The total energy of a deep-water gravity wave is divided equally between potential and kinetic energy; the potential energy results from the displacement of the wave surface above and below the mean ocean surface, the kinetic energy — localized near the surface — is present in the rotation of water particles. Historical schemes to harness wave energy have been limited since they were able to use only either the potential energy or the kinetic energy of the wave, but not both.

One early proposal for harnessing wave energy involved a number of paddle wheels to be rotated by incoming waves. In this case only the kinetic energy was used, and since an individual paddle intercepted the wave in only one small area, the number of paddle wheels required was prohibitively large. In another approach, a series of floats was arranged to rise and fall with variations in the height of the waves. Here only the potential energy of the wave was available and the required surface areas of the floats was necessarily too large.

Although we are here concerned with wave power and *not* tidal power, some mention of tidal projects is worthwhile. There have been a number of proposals for driving generators by impounding water at high tide and letting it run out at low tide. Unfortunately there are only seven known locations in the world where the tidal range is at least 25 ft, the minimum required to develop adequate power. Large enclosures are required to impound the water during the six-hour cycle between high and low tides.

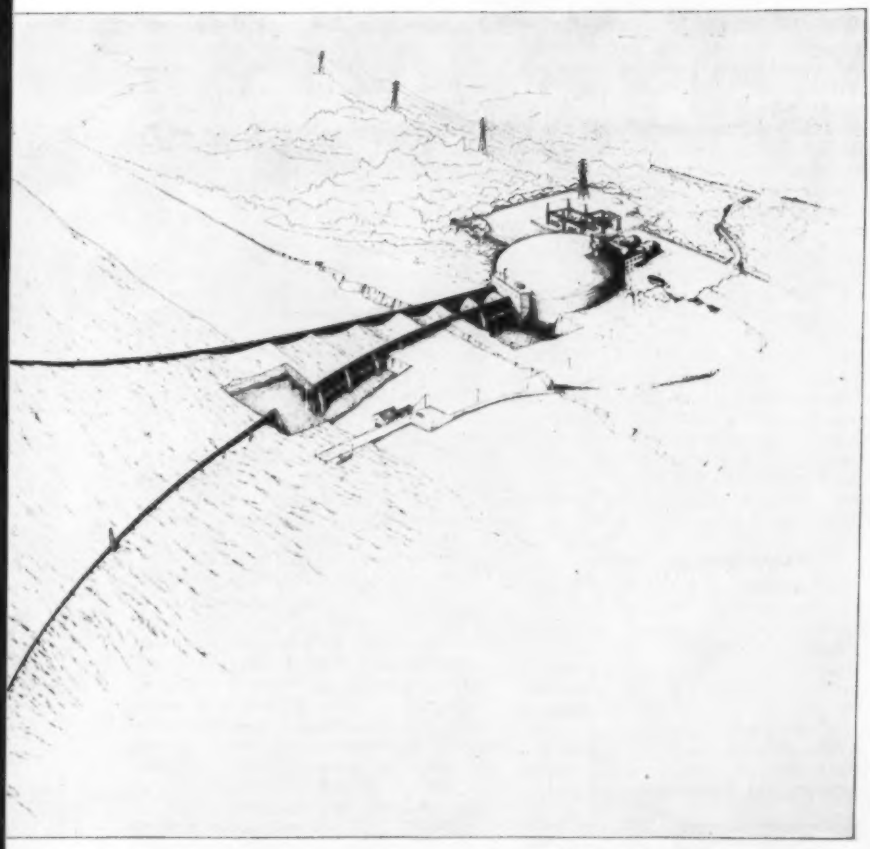
The Resonant Port

A number of investigators have studied the phenomenon of periodic fluctuation — or "seiching" — of the water level of harbors and basins. However, this work was directed toward the elimination, or at the least, toward the decrease of such undesirable effects on harbor facilities and ships at anchor.

Seiching occurs when the frequency of the incoming waves coincides with a natural vibratory frequency of the water in the harbor, so that the harbor water resonates. It is often overlooked that a liquid system can oscillate in a manner similar to a tuning fork or a crystal goblet. In a harbor, the entire body of water partakes of the motion, so that the harbor water will rise and fall in a manner depending on the shape of the boundaries. San Francisco Bay has, on occasion, oscillated as much as 6 in. due to long-period waves from undersea disturbances in the Pacific Ocean. Table Bay, South Africa, often fluctuates several feet with a defined frequency. Los Angeles harbor disturbances have broken hawsers and pulled up anchors while ships were docked or at anchor within the safety of the harbor. To the observer, the surface of the water appears smooth, yet ships are observed to rise and fall several feet for no apparent reason.

The author has proposed to use this type of resonance in a circular, water filled port, or in a small artificial harbor, as a method of generating power from ocean waves. This approach would use a converging channel to collect wave energy, and then transfer this energy by causing the incoming waves to set up resonance within the water-filled port. The periodically rising and falling waves in the port

* Wave Power Project, Arthur D. Little, Inc., Cambridge, Mass.



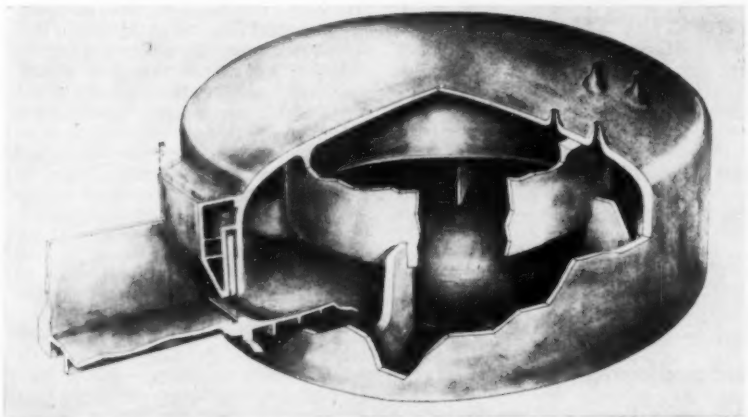


Fig. 2. Design of circular port chambers; configuration conforms to wave pattern

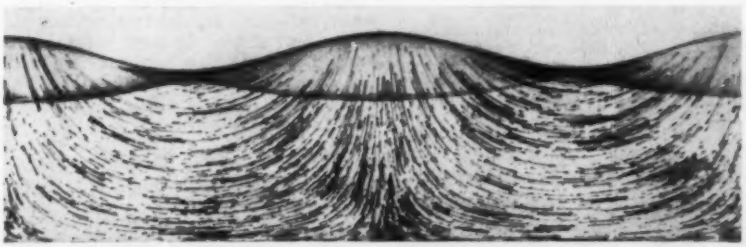


Fig. 3. Reproduction of photograph of standing wave system in a rectangular channel shows particle motion in wave cycles (photo by Wallet and Reullan, 1950)

behave as a "liquid piston", simultaneously compressing and expanding air. The air itself is the "working fluid" and would drive an air-turbine to generate power.

Figure 1 is a conceptual drawing of a full-scale generating station powered by ocean waves. The "horn-shaped" channel is 1500 ft long and intercepts a 1000 ft wave front. The port, itself, is a circular concrete cylinder 240 ft in diameter, capped by a dome. At the center, the port is 150 ft in height.

Behavior of Port

The behavior of the resonant port is best described by following the progress of a wave through the system. The design wave is 4 ft high (trough to crest), 180 ft in length, and has a period of six seconds. The wave itself originated out in the ocean, being generated by storm winds at any one of a number of widely scattered locations. To an observer, it is scarcely visible, appearing as little more than a gentle swell on the ocean surface, yet waves of this type can "travel" a distance equivalent to the earth's diameter before losing one-half their energy.

This traveling wave "couples" with the channel entrance and a standing-wave (clapotis) forms which is twice the height of the original wave. As we view the standing wave system from successive stations along the channel itself, the individual waves become progressively higher because of both the convergence and decreasing depth of the channel. As may be seen from Figure 1, the channel slope differs from the natural beach slope. The channel depth is sufficient to prevent "breaking" of the standing wave and thereby avoid the rather substantial energy loss which would otherwise occur.

At the port entrance the wave front — originally 1000 ft wide — has narrowed to 40 ft in width and is now 52 ft high (trough to crest). Figure 1 shows the change in appearance of the wave as it "traverses" the channel.

Wave System Transformed

The details of the port entrance and the port itself are shown in Fig. 2. An overhead gate is located at the entrance. This gate is lowered sufficiently below the still-water-level to seal off the port and prevent any leakage of air to or from the port itself.

Within the port itself, the standing-wave system is transformed in a striking fashion. To persons not acquainted with this behavior, the water surface appears to defy the rules of fluids. The water alternately rises to form a great dome, and then drops to form a saucer-shaped surface (Fig. 3). During this six-second cycle the water surface at the center of the dome varies 120 ft in height.

To achieve a "liquid-piston" effect and thereby compress and expand air, the working-fluid in this case, the

port must be modified. Figure 2 illustrates the necessary modification. A thin-walled cylinder extends downward from the top of the port-dome to a point slightly below the still-water-level of the port. This cylinder, then, divides the air-space above the water surface into two parts — the inner air-chamber being a cylindrical volume and the outer air-chamber being an annular volume.

The partition, itself, is 160 ft in diameter. Its dimensions are determined by a zero-displacement circle. This circle is the tracing of that part of the water surface which remains stationary throughout the operating cycle of the port. During one-half the cycle, the water surface inside this circle will rise to form the "dome", while the water surface of the outer annular ring will be similarly depressed in a continuation of the dome-shaped surface. During the second-half of the cycle, the situation is reversed, with the inner water surface forming a saucer and the outer annular-surface rising upward in a continuation of the saucer. Again the circular tracing remains stationary.

Energy Transfer

The port system has, so far, served only as an energy-conversion device. The low-grade potential and kinetic energy content of ocean waves has been converted to high-grade potential energy. This is analogous to the function of a regional watershed and river system. The function of such a system is simply to collect low-grade energy (rain and melting snow) and provide a source of high-grade energy concentrated in the main river system.

To transfer the energy from the circular port, the rising and falling of the water within the port is used to compress and expand air. During the first half cycle, the elevated water surface will exert a positive pressure, plus P, on the air in the inner chamber. At the same time, the water surface in the outer annular chamber is depressed, exerting a negative pressure, minus P, on the air in the outer chamber. If we connect the two chambers by means of a pipe, across the outside of the concrete dome, air will flow between the two chambers due to a pressure difference of 2P between the chambers. (The direction of air-flow will, of course, be reversed every half-cycle.) An air-turbine may be interconnected with the piping system and thereby extract energy from the port. In practice, two sets of pipes and appropriate valving will be used to maintain a unidirectional flow of air through the turbine. A surge tank is used to smooth out pressure fluctuations during the operating cycle. Figure 1 shows piping connections to the surge tank, behind the port. The air-turbines and associated generators and electrical equipment complete the wave-powered generating station.

Economics of Project

Present status of this project does not warrant more than a brief economic analysis. The initial cost of the 50,000-kw prototype is estimated to be $11,000,000, resulting in a capital cost of $215 per kw. (A theoretical efficiency of 100 per cent is assumed for this case.) Following is a comparison of initial cost per kilowatt of the prototype with a recent hydroelectric plant of the Idaho Power Co.:

Wave-powered prototype (100 per cent efficiency)	$215.00
Idaho Power Co. (Strike Dam)	$225.00
Wave-powered prototype (50 per cent efficiency)	$430.00

There are three different efficiencies associated with the wave-powered prototype. The efficiency of energy conversion associated with the circular-port itself; the efficiency associated with the percentage of time waves of various heights and directions are acting on the prototype; and the mechanical efficiency of the turbine generator that uses the power.

The above comparison, undoubtedly neglects significant energy losses; the intent here, however, is simply to show "order-of-magnitude" costs as compared to actual hydroelectric costs. The important point is that initial costs of the wave-powered prototype fall within the range of conventional power projects.

Outlook for Future

The use of resonance, as an energy conversion device, is one of the most promising approaches for obtaining power from ocean waves. Whether it will become economically successful must await further research. Activity in this field is presently overshadowed by nuclear power developments and the problems yet to be solved in obtaining power from ocean waves are formidable. However, the prospect of successfully using this available energy is sufficiently challenging to warrant serious attention by the electric power industry.

Looking beyond the present ADL studies, the knowledge required to develop this concept fully is somewhat overwhelming. A meteorological analysis of available wind energy over extended periods of time is required. Secondly, a thorough study of wind-wave propagation and analysis of the frequency content of wave groups presents an oceanographic problem. Thirdly, behavior of the channel port system itself is a major problem in hydrodynamics. It seems to be typical that today's technological problems overlap several scientific disciplines and therefore require contributions from a number of people in different fields to bring about a solution.

It is hoped that this discussion may encourage comments by people working in this or related fields. Such guidance would prove invaluable in determining the direction of future wave-power studies, as well as in focussing attention on an energy source which has been long neglected.

Ten Technical Groups Unite to Form New Joint Committee for Standardizing Water Tests

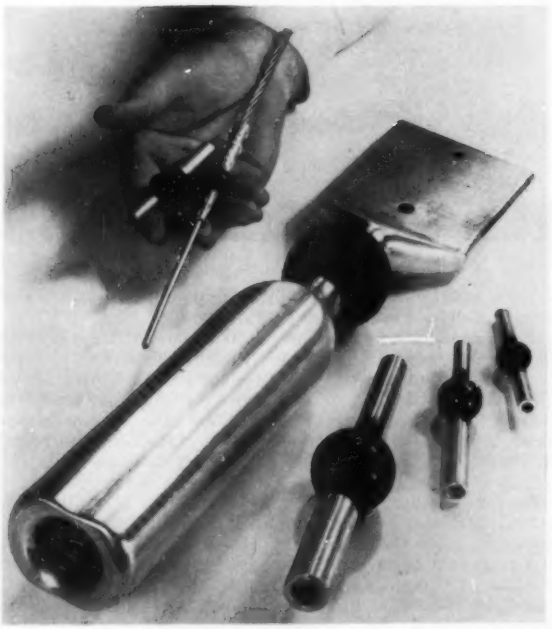
IN JANUARY, 1956, at Biloxi, Miss., the new Joint Committee on Uniformity of Methods of Water Examination (JCUMWE — pronounced, ja-kum'-wee) was formed to promote and establish uniformity of water testing methods and to provide a medium for exchanging information among members. The organizations responsible for this move are those most influential in preparing, adopting, and publishing water examination methods in general use for natural water, potable water, industrial water, industrial waste water, and sewage. The ten technical groups which are sponsoring the Committee include the following:

- Committee on Disposal of Refinery Wastes of the American Petroleum Institute
- American Public Health Association
- American Society of Mechanical Engineers
- American Society for Testing Materials
- Association of Official Agricultural Chemists
- Federation of Sewage and Industrial Waste Associations
- Manufacturing Chemists Association
- Technical Association of the Pulp and Paper Industry
- United States Public Health Association (R. A. Taft Sanitary Engineering Center)
- The Geological Survey (U. S. Dept. of the Interior)

The recommendations of the Committee will be advisory only and will not supplant or impede the work and publication policies of the participating members.

Purpose of the Committee, in addition to standardizing testing methods, includes reviewing methods with respect to objectives, sampling, apparatus and reagents, procedure, reporting of results, and applications. This should be the answer to problems that have plagued laboratory men for years, and be the instrument whereby a test by one "standard method" will give the same answer as an equivalent test by any other "standard method." Such action by industry is always gratifying.

Applications for committee membership by any non-profit organization interested in helping to unify water test methods may be mailed to the Secretary, JCUMWE, % Refinery Technology Laboratory, Gulf Oil Corp., P. O. Box 7409, Philadelphia 1, Pa.



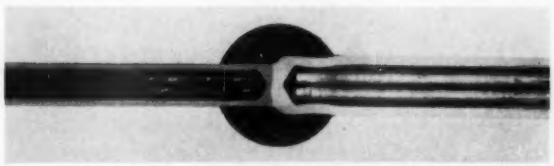


Fig. 1. Above: Cross section of connector shows how aluminum cup and copper cup with closed ends are butt-welded together and hermetically sealed in rubber ball and cement

Fig. 2. Representative group of new conductors which are designed particularly for use in highly corrosive atmospheres

Al-Cu Connector Resists Corrosion

WITH MORE and more aluminum being used by the electrical industry, the problem of joining aluminum and copper has been receiving increasing attention in recent years.

This research is beginning to pay off in new and more reliable methods of jointing aluminum and copper, and one such connector which has been recently announced is described here. It has been subjected to severe field and laboratory tests since 1953 and has proved very satisfactory.

The connector consists of two cups, one aluminum and one copper, butt-welded back to back, as shown in Fig. 1, with the joint protected by thermosetting insulating material. A ball shape was chosen for the protective material because it sheds liquids and dirt easily and is less subject to mechanical damage.

Flash or pressure butt-welding, used to join the aluminum and copper cups, produces a very strong bond. Tensile tests on the connectors show that the bond strength is actually greater than the ultimate tensile strength of the aluminum, and this method of welding adds practically no electrical resistance to the joined sections.

In addition to laboratory tests, cyclic loading and weathering tests have been carried out at highly corrosive Atlantic and Pacific coastal points where severe wind and salt spray conditions prevail; in California and Utah desert areas where they were subject to severe salt and alkali-laden atmospheres with very little rainfall; and in heavy industrial areas such as Chicago, Pittsburgh, and St. Louis. In all cases the joints were found to be unaffected by the corrosive atmosphere.

In laboratory tests the connectors were subjected to accelerated salt corrosion and severe overload tests. For example, connectors rated at 135 amp full load current were completely stable following cycles of 500 amp a-c applied for twenty seconds in each cycle. Internal resistance as measured at points ¾ in. to either side of the weld averaged 22 microhms initially and remained unchanged throughout ten high-current cycles.

Both conventional and impact-type tests on the welds showed that failure occurred in the parent metal rather than in the weld. Connectors with conductors permanently compressed in the barrels also were subjected to tensile tests. The conductors always failed before the connector showed any deformation.

Though satisfactory for general use the connectors have been designed particularly for use in marine and other highly corrosive atmospheres where other connectors failed.

If you want more information about this new connector write CONNECTOR on one of the prepaid post cards elsewhere in this issue and mail it to us.

330-kv Tie Will Join Two Large Systems

AT NEW CARLISLE, Ind., the systems of American Gas and Electric and Commonwealth Edison are closely interconnected. In order to increase facilities for interchange of power between the two systems in case of breakdown or abnormal demand on either system, a new extra-high-voltage transmission line will shortly be constructed as a tie between the two systems.

The line, which will be 90 miles long, will operate at 330 kv and initially will be able to transmit 300,000 kw. Ultimately it will transmit up to approximately 1,000,000 kw. Capacity of existing interconnections for the transmission of emergency power is only about 50,000 kw.

The line will consist of six conductors, each 1¾ in diam. Approximately 500 steel towers, most of them 145 ft high, will carry the conductors and the project will cost approximately $25,000,000.

The two systems to be interconnected rank among the nation's largest. AG & E has a generating capability of 4,000,000 kw and Commonwealth Edison has about 3,900,000 kw.

Copper shortages and rising prices have encouraged the electrical industry to search for substitutes. Aluminum, provided proper jointing methods are employed, is proving very satisfactory

Aluminum Makes Good Substitute for

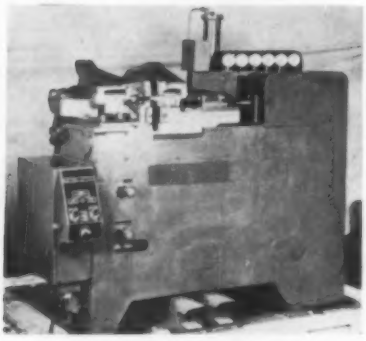


Fig. 1. Typical flash welder as used to make transition sections shown in Fig. 2

By D. M. CALABRESE *
and
C. L. CARSON †

REPEATED SHORTAGES of copper have encouraged the use of aluminum wherever possible. Furthermore, copper prices have more than tripled since 1946 while in the same period aluminum prices have increased only 63 per cent. The price of copper ingot when based on equal conductivity is about three times that of aluminum ingot. The electrical industry is expected to double in size in the next ten years and double again in ten more. This expansion will undoubtedly require the use of increasing amounts of aluminum in place of copper.

One of the chief deterrents to wider use of aluminum as an electrical conductor has been the difficulty encountered in making satisfactory electrical connections. Aluminum can be easily joined for electrical purposes by inert-gas metal-arc welding. Copper, of course, can be readily soldered.

One successful means of effecting an electrically satisfactory connection between copper and aluminum is flash welding transition sections. Flash-welded transition sections of copper and aluminum make possible the use of aluminum and copper in any desired combination. A typical flash welder similar to those used in making the transition sections is shown in Fig. 1. Welding an aluminum conductor to the aluminum end of the transition section and soldering a copper conductor to the copper end of the section produces a satisfactory low resistance joint, as shown in Fig. 2. This type of connection has been used in the design of several large d-c machines in which aluminum was successfully substituted for copper in the main field coils.

Joining Problems: If the shunt field circuit of a d-c motor opens during operation, the motor tries to "run away" and approaches infinite speeds due to the loss of flux. As a result, the rotor windings and commutator bars could fly out of the motor causing extensive damage. Because of this, improper electrical joints in the shunt field circuit absolutely cannot be tolerated. Soldering the aluminum windings directly to the copper circuit is not sufficiently reliable over a period of time.

The problem of joining in the shunt field wiring was solved by the use of an electrical connection that is as strong as the aluminum wire. In making the connections, inert-gas metal-arc welded joints, flash-welded aluminum-copper transition joints and soldered copper joints are used. One such joint is shown in Fig. 3.

By welding the aluminum end of the transition joint to the end of the field coil before it is assembled into the frame of the machine, the process of wiring on final assembly is no different than when the field coils are wound with copper wire. No special tools or techniques are required in the final wiring. Figure 4 shows a typical field pole with aluminum coils wound on the pole before it is assembled in the frame.

Should it become necessary to change the shunt field coil circuitry in the field, the joint is simply broken on the copper side of the transition joint or somewhere in the copper cable wiring by melting the solder. Then joining can be done again simply by soldering.

The production of the aluminum-copper transition joint involves a unique process. In flash welding copper to aluminum, heat for melting the end surfaces is obtained from a succession of arcs. The rate of approach is accelerated during the flashing period and at current cutoff, a sudden increase in travel speed and force gives a high forging pressure. This sudden impact ejects slag, oxides, and molten metal and the mass of the clamps rapidly cool the joint.

The self-cleaning nature of the flash welding process permits only a very small amount of alloy layer to remain in the joint between aluminum and copper. Embrittlement of such a joint will arise only as a consequence of unusual heating conditions subsequent to welding. The characteristics of the alloy layer barely begin to affect the over-all behavior of the transition joint only when the layer grows by mutual diffusion of the joined metals to a thickness of 0.00004 in.

In impact tests, the joint becomes completely brittle when the layer reaches a thickness of 0.00009 in. In terms of ageing time, four days at 215 C are sufficient to cause a slight decrease in impact strength and 28 days to cause serious loss of impact strength. In tension, the joint will remain sound even after the 0.00009 in. thickness of the alloy layer has been exceeded. The effects of temperature and time on embrittlement of aluminum to copper transition joints are shown graphically in Fig. 5.

Because of the possibility of embrittlement of the aluminum-copper transition joint at high temperatures, care must be exercised in keeping the joint from becoming too hot while joining the aluminum conductor to the aluminum end of the transition section with the inert-gas metal-arc weld. Application of wet asbestos during welding conducts enough heat

Aluminum and copper wire compared

TYPE OF WIRE	COPPER RECTANGULAR	ALUMINUM RECTANGULAR
Ampere Turns	5500	5500
Wire Size (inches)	.109 x .129	.129 x .164
Turns	432	393
Length of Wire (feet)	11,000	10,500
IR Drop (volts)	113	1J8
I^2R Loss (watts)	1440	1665
Sq. Inches Rad. Surface per Watt Loss	3.7	3.7
Bare Weight	521	246
Field Current (amperes)	12.7	14

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Copper in Large D-C Machines

from the joint so that impact strength is not affected.

Design Considerations: With the necessity for substituting aluminum for copper becoming greater, Westinghouse engineers searched for space in the d-c machines. Aluminum has approximately 61 per cent of the conductivity of copper, which means that a larger volume of conductor per machine would be needed with the substitution. Coupled to this problem is the increasing demand for smaller machines. It appeared that the size of the d-c machine would be seriously affected.

As a practical example of the substitution of aluminum for copper in large d-c machines, consider the two shunt field coils described in Table I. Both shunt field coils are designed to produce the same magnetomotive force, i.e., ampere turns per pole. One coil is wound with rectangular copper wire and the other with rectangular aluminum wire but both are insulated in the same way.

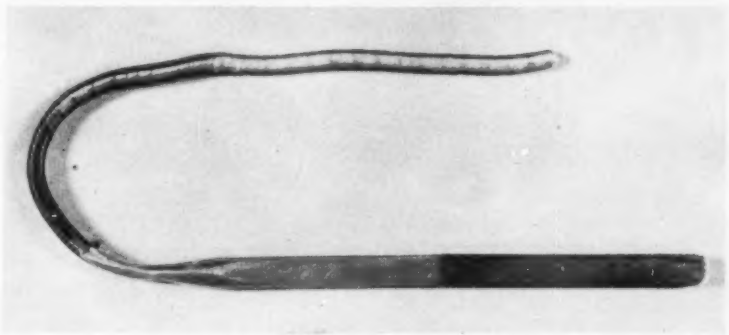

Fig. 2. Typical flash-welded aluminum-copper transition joint welded to an insulated aluminum conductor. Copper joint is soldered by standard shop methods

If the two coils are to have equal voltage drops, the cross sectional area of the aluminum conductor must be 1.64 times as large as that of the copper conductor. This arises from the fact that the voltage drops of the coils are inversely proportional to their conductivities and cross sectional areas when their mean lengths of turn are equal. This is approximately true for the coils in Table I.

Assuming the heat dissipating capacity of the two coils to be the same, their insulated radiating surfaces for a given heat loss should be the same, i.e., the square inches of radiating surfaces per watt loss is equal for the two coils. Since the radiating surface varies with the wire size and number of turns and the heat loss varies inversely with the number of turns, the coil wound with copper will have 1.13 times as many turns as the coil wound with aluminum whereas its current will be 0.9 times as great.

It would seem then that using aluminum wire in shunt field coils of d-c machines should increase the size of the machine. This is not necessarily true if the armature conductors

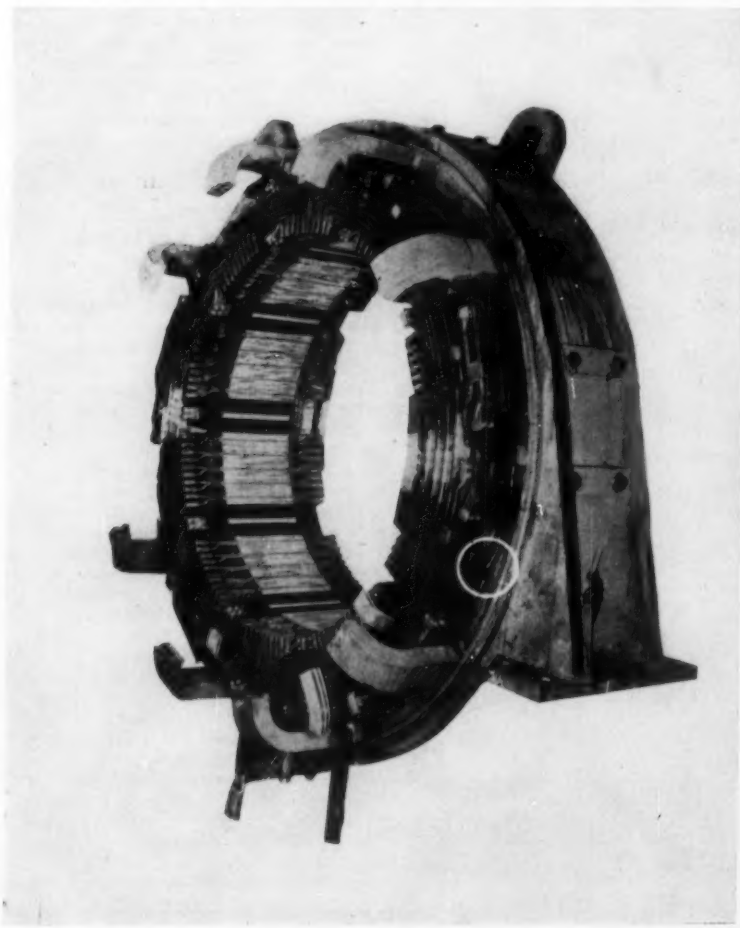

Fig. 3. Stator of large machine with aluminum wound field coils. Encircled joint is a flash-welded aluminum copper transition joint same as shown in Fig. 2

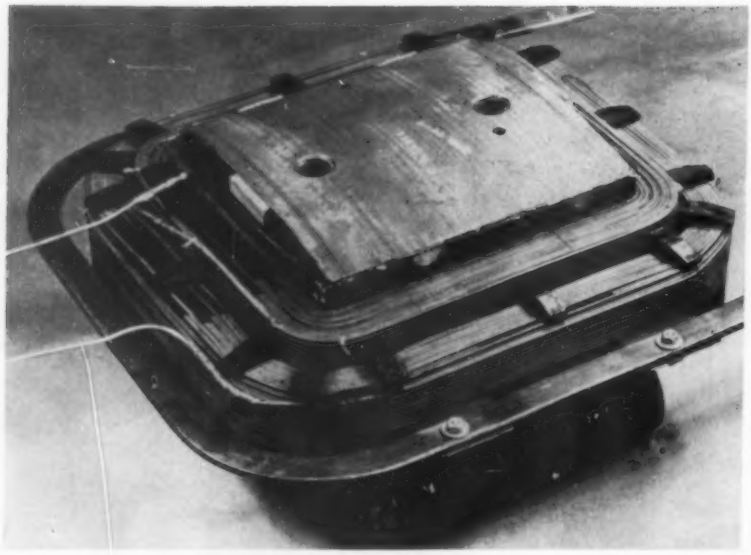

Fig. 4. Main pole of a d-c machine with aluminum shunt and series field coils

are copper. In selecting a size of machine for a specific output and application, the capacity of the armature is of prime importance. Fortunately the space allowance for field coils is more liberal than for armature conductors. In some 15 to 20 per cent of the large d-c machines built, this space allowance is liberal enough to permit aluminum wire to be substituted for copper wire in the main field coils without changing the size of the machine.

The figures in Table 5 show an increase in heat loss when using aluminum. Even though the heat dissipating capacities and therefore the temperature rises of the two coils are equal, the increased heat loss is possible due to the greater radiating surface. With the use of separate excitation, this should require a corresponding increase in exciter capacity. However, by taking advantage of all the variables involved in the design of field coils, more turns could be used. This would decrease the current and heat loss and hold the exciter capacity to a minimum.

With space now being the chief limiting factor in the substitution of aluminum conductor for copper conductor in large d-c machines, the next step is to make substitution where space is not at a premium. The compensating and commutating coil end connections and the brushholder cross-connections are located in the front and rear of the pole construction with very little restriction in space in the axial direction.

These conductors, which are formed to the proper shape before being assembled in the machine, are now made of copper strap. Aluminum can be used here in place of copper. With the introduction of the higher strength aluminum, the problem of cold flow is practically negligible so that ordinary bolted connections may be readily used.

Conclusion: Use of aluminum as a substitute for copper in motors should become more widely accepted now that joints can be an integral part of the conductor instead of just a link between component parts.

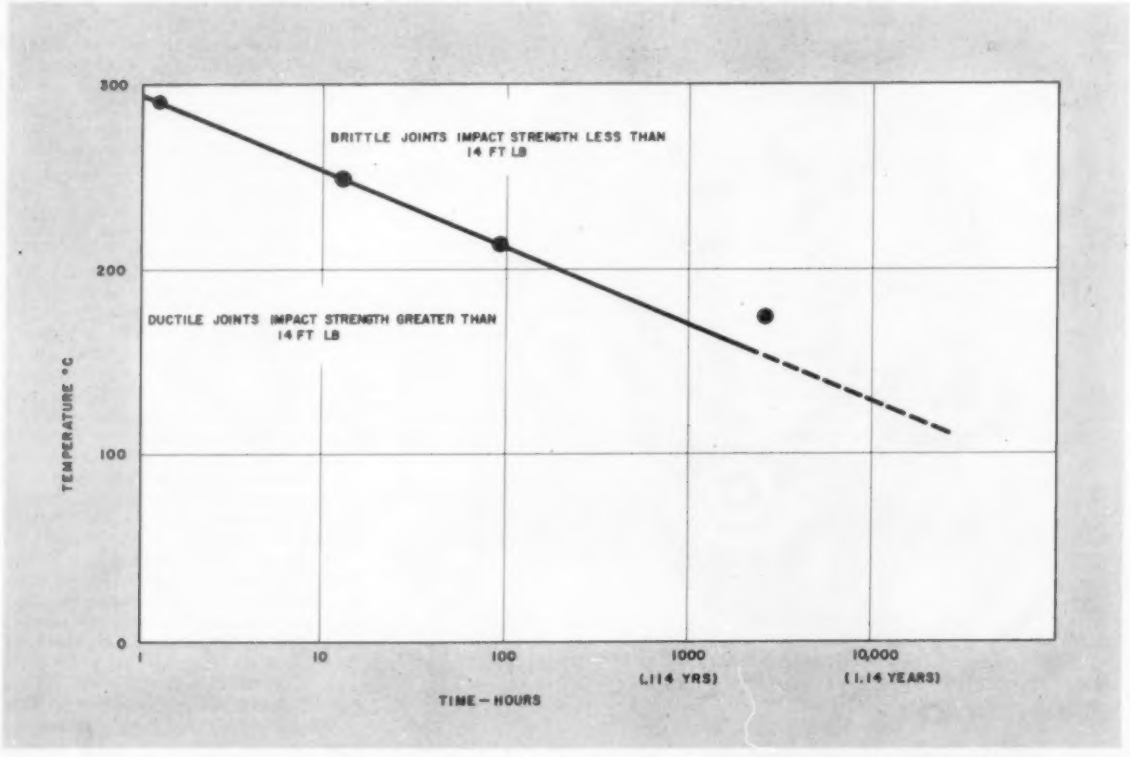

Fig. 5. Shows the length of time transition joints must be held at constant temperature before becoming brittle in impact

Fig. 1. Measuring hydrazine concentration with colorimeter

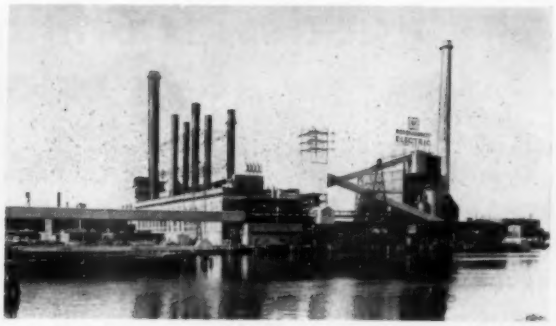

Fig. 2. The Narragansett Electric Co.'s South Street Station

South Street Reports on Hydrazine

AT THE SOUTH STREET Station of Narragansett Electric Company, Providence, Rhode Island, hydrazine has been used from the start in the two new Babcock & Wilcox boilers. Each of these boilers is capable of producing 500,000 lbs of steam per hour at a pressure of 2,200 psig.

On November 18, 1953, one of these new boilers was filled with condensate prior to the running of a hydrostatic test. Sufficient disodium phosphate, caustic soda, and hydrazine solution was pumped into the boiler water to maintain the following conditions: pH 10.16, phosphate residual as PO_4 33 ppm., and hydrazine residual as N_2H_4 3.5 ppm. The same treatment was used in the other boiler.

Control of Hydrazine Feed

In the beginning, no satisfactory method was available whereby trace quantities of hydrazine in the feedwater could be determined. It was found, however, that the amount of hydrazine to be added to the feedwater could be controlled by keeping the conductivity normal in the condensate. Then in July, 1954, a method for determining small quantities of hydrazine became available and was put to use. By this new method it was found that 0.2 ppm. hydrazine was being added continuously to the feedwater.

Shortly after one of the new boilers went on line June 10, 1954, dissolved oxygen in the feedwater was found to be 0.17 ppm. By June 25 the dissolved oxygen was down to 0.02 ppm. and it remained at around 0.017 ppm from June 25 to December 10, 1954 with an excess of 0.2 ppm hydrazine present in the feedwater going to the boilers. The amount of hydrazine used is 0.0415 lb of 54.4 per cent N_2H_4 solution per million lb steam.

The outstanding advantage of hydrazine in this boiler installation is considered to be freedom from solids in the water; these must be avoided because of the spray-type attemperators. Also the acidic decomposition products of sodium sulphite cannot be tolerated in this installation.

Continuous addition of hydrazine solution to the feedwater is now standard practice in these boilers, and the test engineer states he would recommend the use of hydrazine in other power plant boilers operating under similar conditions.

Photographs courtesy Olin Mathieson Chemical Corporation

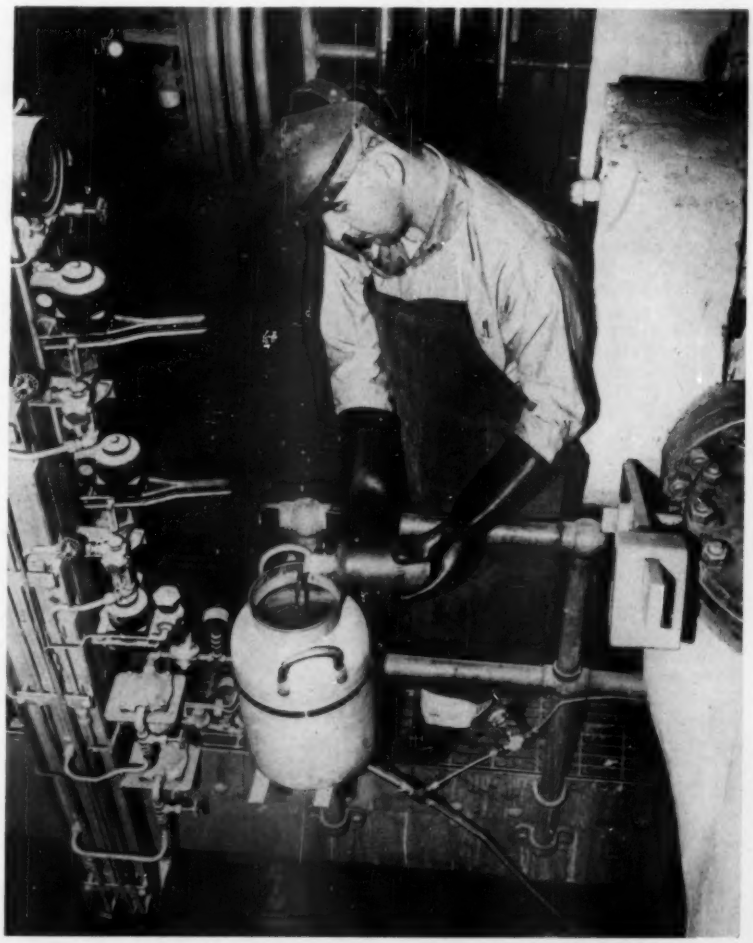

Fig. 3. Adding hydrazine solution to a known volume of water in feedwater line

Packless Stuffing Boxes . . . Pro and Con

Packing tends to be weakest part of high speed BF pumps, so trend is to build pumps that need no packing. Here, in third article of BF pump series, are details of stuffing boxes that use no packing

By IGOR J. KARASSIK*

WE HAVE SHOWN that in some cases boiler feed pumps can be successfully packed against very high pressures and temperatures. We have also described various means available to reduce the severity of service on the stuffing boxes by incorporating ahead of them either single or double pressure reducing breakdowns. In spite of these improvements, steam power plant operators have never ceased to urge pump designers to provide a still better solution to the stuffing box problem — nor have the pump designers ceased to search for it.

The major argument in favor of the elimination of stuffing box packing and using some other method of dealing with leakage from inside the pump to the outside is that repacking takes the pump temporarily out of service. The design of the pump internal parts and the metallurgy used for these parts have now progressed to the point that a high pressure boiler feed pump can run from 60,000 to 120,000 hours between complete overhauls. Impressive as such records are, the fact that a pump has to be shut down every 6 to 18 months for the purpose of repacking it detracts considerably from this achievement in availability. In other words, the search has been concentrated for some solution of the stuffing box problem which would give this part of the pump a life equal to the life of all internal pump parts. Two widely diverging solutions have been put forward recently: the use of mechanical seals and the so-called "packless" stuffing box.

Mechanical Seals: A great deal of interest has been directed to the possibility of applying mechanical seals to boiler feed service. As a matter of fact, a few isolated cases exist where such seals have been installed. However, results to date are still inconclusive because of the need of long time operation before acceptance can be given. And even if operating records of several thousands of hours have been logged in several cases, the potential danger of sudden and unexpected failure must be explored, for if such a danger exists, the mechanical seal cannot be seriously considered for this service.

The author's distrust of the mechanical seal for boiler feed service is based on two separate factors. The first is that, regardless of its design, any mechanical seal is based on close rubbing contact between two faces in a radial plane. This rubbing contact would result in wear and rapid failure unless lubrication is provided in the form of a liquid film. But water at the temperatures handled by boiler feed pumps does not have sufficient lubricating qualities and the film is subject to breaking down either in local spots or completely. Thus the danger of rapid wear of the rubbing faces makes us extremely suspicious of the ability of such a seal to stand up for long periods of time. We shall come back later to this problem of proper seal lubrication.

In addition to this, the operation of a mechanical seal is based on the assumption that the rotating and stationary faces will remain exactly parallel to each other; that is, that no appreciable angularity will exist between the two. However, since the stuffing boxes are located very close to the pump bearings, the deflection at that location is very low while the angularity of the shaft is almost at its maximum.

Holding seal leakage temperature down: It is obvious that mechanical seals can be successful in boiler feed pump application only if the seal leakage, slight though it be, can be held to a temperature below flashing so that the leakage is water rather than steam. This can be accomplished either by injecting cold condensate at the seal or by providing some external means of cooling the water surrounding the seal and contained in the stuffing box.

To accomplish the latter, it becomes necessary to incorporate a small pumping element mounted on the pump shaft next to the seal which will circulate the water contained in the stuffing box through an external heat exchanger. However, this pumping element will circulate the seal cooling water only if the pump is running, and circulation will stop once the pump is brought to rest. A slight amount of circulation may be obtained through the heat exchanger by means of a thermal syphon. This, however, may not be quite adequate for the desired pur-

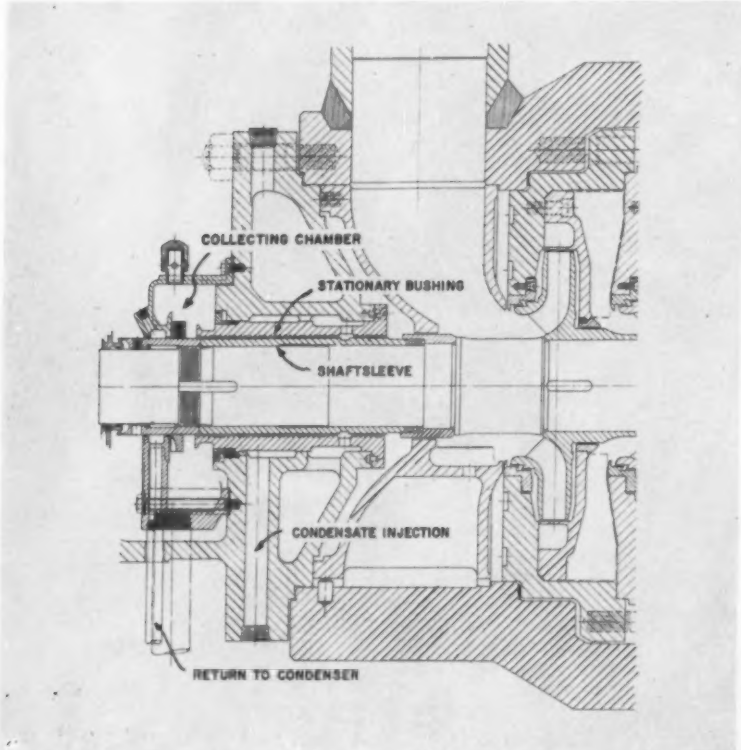

Fig. 1. Section through a packless stuffing box for modern high pressure BF pump

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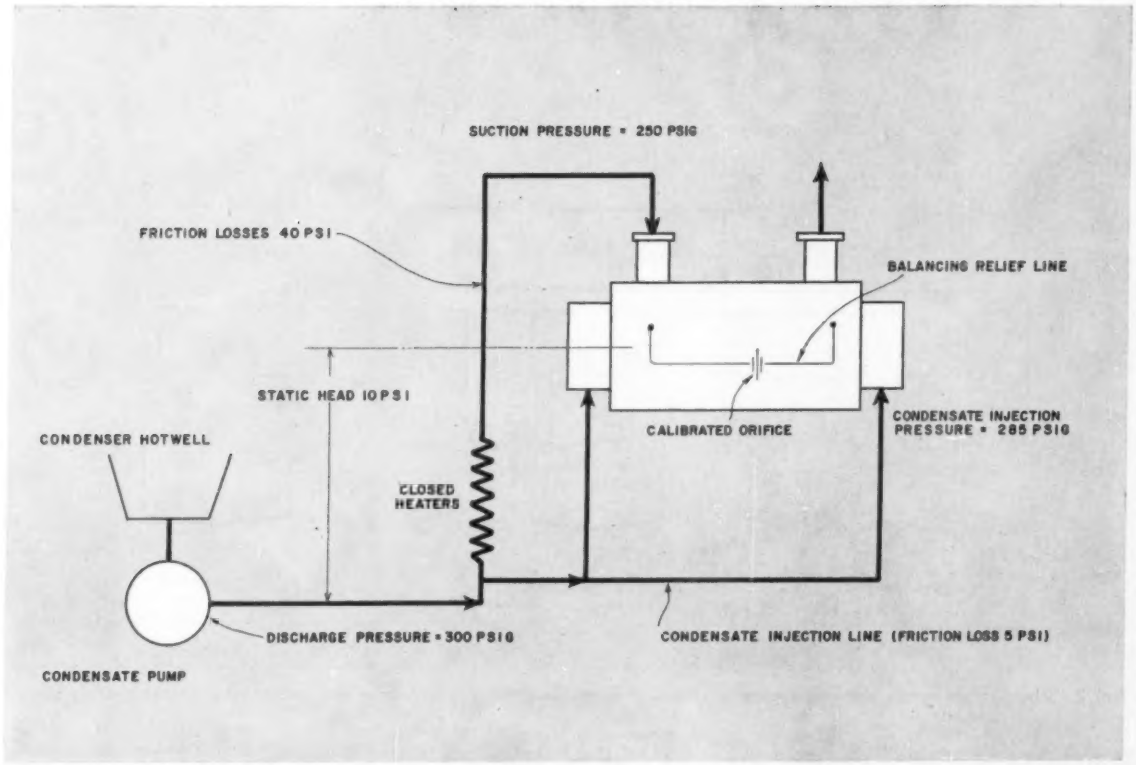


Fig. 2. Schematic diagram of closed feedwater cycle showing distribution for injection supply to packless stuffing boxes

pose. As a result, to provide cooling to the mechanical seals of a pump on standby service and warmed up to full temperature it is necessary to provide either a cooling water jacket around the seal chamber or cold condensate injection. We shall see presently that if the principle of condensate injection is once accepted, the necessity for the mechanical seal itself may be eliminated.

We should not fail to mention another very important problem which arises in connection with the application of mechanical seals, and that is that their operation may be seriously handicapped by the presence of foreign material such as iron oxides or mill scale in the feedwater. Generally, mechanical seal manufacturers state that particles over 2 microns in diameter cannot be tolerated.

It is true that when the seal is new, there should be no appreciable flow from the pump interior into the seal chamber. Hence, once the water within the chamber is purified, no additional impurities would enter therein. Purification can be accomplished by the use of an alnico magnet located in the cooling circuit at some point where it could collect iron oxide and other magnetic impurities. However, as the seal starts to leak, the introduction of impurities into the seal chamber will increase, accelerating wear, and failure would be rapid. In other words, one of the basic objections to the use of mechanical seals in high pressure boiler feed pumps has not yet been overcome.

The Packless Stuffing Box: The most promising solution at this moment is the so-called "packless stuffing box" in which a labyrinth breakdown bushing is substituted for the conventional packing. Cold condensate, available at a pressure in excess of the boiler feed pump suction pressure is introduced centrally in this breakdown bushing. A small portion of the injection water flows inwardly into the pump proper. The remainder flows out into a collecting chamber, from which it is piped back to the condenser.

Fig. 1 shows part of a high pressure double casing boiler feed pump fitted with "packless" stuffing boxes. We should mention at this point that the advent of high speed pumps, operating at speeds from 6000 to 9000 rpm has been one of the major factors in advancing the cause of the "packless" stuffing box, as packing absolutely cannot be made to perform satisfactorily in the range of rubbing speeds encountered and we lack entirely the necessary experience with mechanical seals operating at such speeds.

We have stated that cold condensate (at temperatures from 80 to 100 F) is available at pressures in excess of the boiler feed pump suction pressure. This is true of closed cycles (See Fig. 2) as well as of open cycles, where the condensate pump discharges into a deaerating heater from which the pump takes its suction. In both cases, the water for the injection would be taken immediately from the condensate pump discharge, before it has gone through any of the closed heaters.

In the closed cycle, all deaeration takes place in the condenser and therefore the injection water is fully deaerated. While this is not quite true in the case of the open cycle, we should remember that an appreciable amount of deaeration takes place in the condenser even though a deaerating heater is provided in the feed cycle. In addition, the amount of injection water which enters the pump is very small and no appreciable contamination will occur.

The amount of the injection water will depend upon the diameter of the running joint between the shaft sleeve and the pressure breakdown bushing, the clearance at that running joint and the injection pressure. To give some general idea of the values in question, with a 5 in. sleeve diameter, in a pump operating at 3600 RPM and with a 0.009 in. diametral clearance, the amounts will be approximately:

a) Total injection, per box 8 to 10 gpm
b) Leakage into the pump interior, per box . . 2 to 4 gpm
c) Returned to condenser, per box . . . . . 6 to 8 gpm

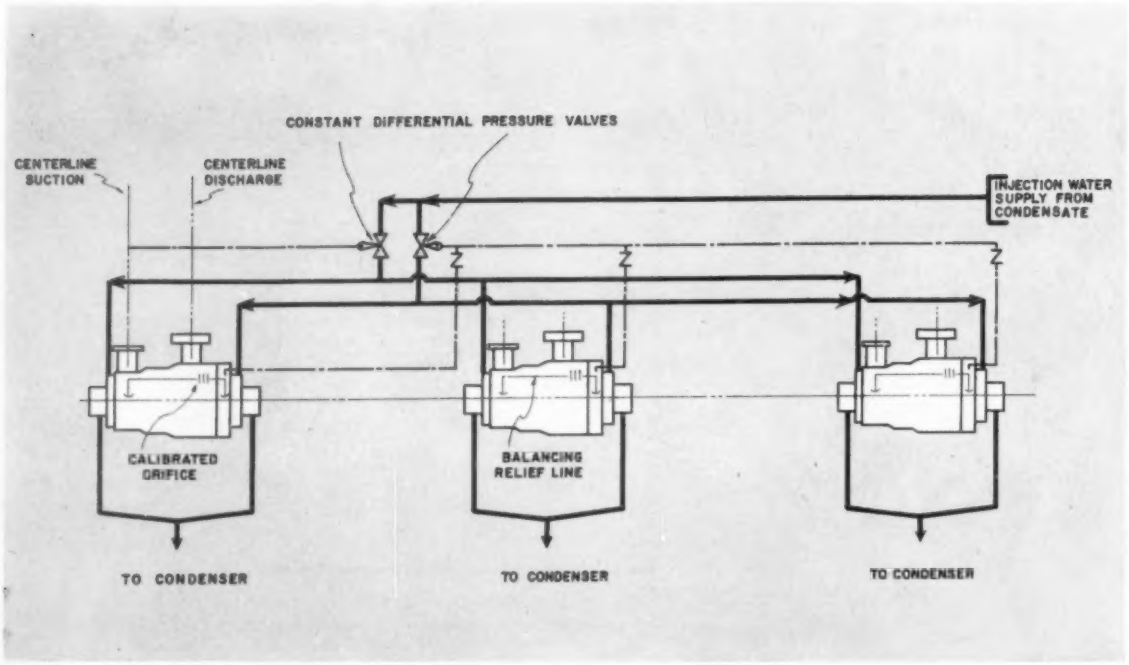


Fig. 3. Schematic diagram showing typical method of controlling the injection flow to a series of packless stuffing boxes

The clearances will double in a time at least equal to the life of the internal wearing parts. With doubled clearances, the leakage will double. This should be considered when sizing the return drain piping back to the condenser (or to a collecting tank) so that the minimum possible friction losses occur in this return piping. The collecting chamber at the pump stuffing box is vented to atmosphere and the only head available to evacuate it will be the static head between the pump and the point of return. This head must always be well in excess of the frictional losses, as otherwise the leakage will back up and run off at the collecting chamber.

A complete analysis of the effect of the packless stuffing box on the station heat rate as compared to the packed box is beyond the scope of this article and will be treated as a separate problem at a later date. Suffice it to point out that the power required to raise the amount of the leakage from the collecting chamber back up to condensate discharge pressure is more than offset by the savings in power consumption from the absence of packing friction.

The "packless" stuffing box has been field tested in installations which have been operating since 1953 and a large number of pumps operating at 3600 rpm have been equipped with this type of stuffing box. It has also been applied to a 9000 rpm pump in operation since the fall of 1954, though we should add that the pump operating speed has no particular effect on the success of this construction.

Control of the Injection Amount: With all the advantages to be gained from "packless" stuffing boxes from the point of view of maintenance and availability, it is still desirable in some cases to limit the amount of injection water to the minimum possible. This has led to the use of throttling valves in the injection lines in some installations. Their function is to maintain a constant minimum differential between the injection pressure and the pressure at the pump interior.

In some cases, a separate throttling valve is installed at each injection point, in other words two valves per pump. In other cases, the desire for simplifying the installation has led to the use of two valves for each group of pumps serving a common turbo-generator unit. Two valves are used because the pressure on the suction and discharge sides will not necessarily be the same. If one examines Fig. 1, it will be seen that on the suction side, the inward flow has to overcome a pressure exactly equal to the pump suction pressure. On the discharge side, the flow will proceed into the balancing device relief chamber. The pressure there will exceed the suction pressure by the amount of loss through the calibrated orifice in the balancing relief line which is used to measure the leakage past the balancing device. This loss may be quite appreciable after the pump has become worn.

The arrangement of injection control with two valves per set of pumps is illustrated in Fig. 3. The connection of the pilot lines to the control mechanism are omitted from the illustrations. On the suction side, a pilot line will be connected to the suction header. On the discharge side a header will be provided with lines from each balancing device relief chamber and a small check valve in each line so that the highest of the three back-pressures is measured. There is always the possibility that one of the pumps will have experienced greater wear in the balancing device and therefore a greater pressure drop will take place through the leakoff orifice. Then the pressure in the balancing relief chamber of that pump will be greater than in the other two pumps. If all three pilot lines were connected, there would be some cross-flow from the relief chamber under the highest pressure to the other two chambers. The individual check valves will prevent this and the highest pressure of the three relief chambers will be registered but no flow will take place through these lines into the remaining pumps.

It is of prime importance to hold the pressure drop through the control valve to a minimum when there is little pressure difference between the condensate pump discharge and the feed pump suction and when the control valve is wide open. This indicates the use of a relatively large valve. In addition, it is important to avoid control valve complications or possibility of malfunctioning, as cutting off the injection water to a pump handling high temperature water is not to be tolerated.

We shall discuss the operation of packless stuffing boxes under varying load and pressure conditions in the next article of this series.

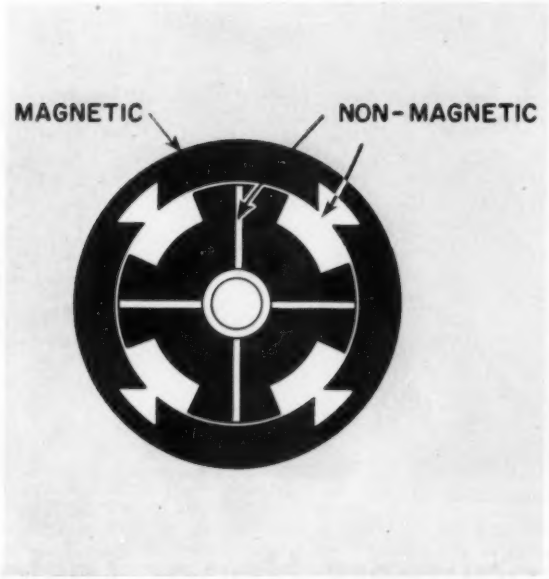


Fig. 1. Diagrammatic section of synduction motor showing how magnetic and non-magnetic material is arranged for maximum reluctance along one axis and minimum along the other

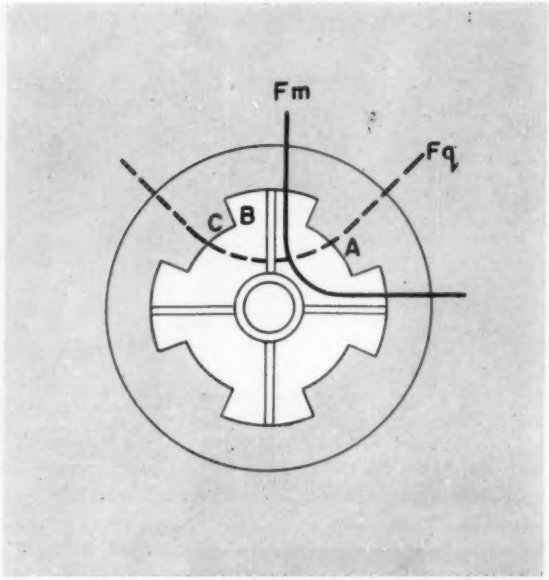


Fig. 2. Quadrature flux Fq is impeded first by large gap A, then by non-magnetic slot B, and then by second large air gap C. Main flux Fm has only normal air gaps in its path

How a SYNDUCTION Motor Works

A few months ago the Allis-Chalmers Mfg. Co. brought out a new type of motor, built like a standard squirrel cage induction motor, but with operating characteristics of a synchronous motor. Here's a simple explanation of the way it works

BOTH FRAME and stator windings of a synduction motor are those of a standard 3-phase squirrel cage induction motor. The frame is roughly the same size and shape and the standard 3-phase winding is the same. The rotor, which makes the difference between this type of motor and an ordinary induction motor, looks very much like a solid squirrel cage rotor, the only difference being the arrangement of slots and grooves in the rotor body which give the motor its particular characteristics.

Figure 1 shows a section through the rotor, and it will be noticed that the grooves make it virtually a salient pole rotor. These salient poles play a significant part in the operation of the motor, whose action is described below.

Running Torque

The running, or synchronous, torque of the synduction motor arises out of an interplay between reactance of the stator and the physical poles of the rotor. For example: when the magnetic or non-physical poles of the stator mmf wave line up with the physical poles of the rotor (a) the reluctance of the magnetic circuit is minimum (b) the reactance of the motor is maximum (c) the current to the motor is minimum and thereby (d) the torque is minimum.

Now suppose that due to an increase in load on the shaft the rotor poles are caused to drop back behind the poles of the stator mmf wave. Under this loaded condition, the reluctance is greater, the reactance is lesser, more current flows into the motor and the torque becomes greater.

In fact, the rotor poles will automatically drop back by an amount to give existence to just the correct amount of torque to match the load torque. The angle between the poles of mmf wave and rotor is called the "torque angle." The motor will not operate at anything but synchronous speed provided the frequency is constant.

It can be shown theoretically that the pull-out torque depends on the ratio between the main pole reluctance, i.e. the reluctance along the axis Fm in Fig. 2 and the quadrature reluctance, i.e. the reluctance along Fq, axis midway between two poles. Thus the construction of the rotor is concerned with making as easy a path as possible for the main flux and as difficult a path as possible for the quadrature flux.

Construction

How this is done is demonstrated in Fig. 2, which shows how the quadrature flux Fq is impeded first by the large air gap in the groove A and then by the non-magnetic barrier formed by the slot B and then by the other groove C, whereas the main flux Fm has only the normal air-gaps in its path.

The shape and size of slots and grooves in the rotor are aimed at increasing the main flux and decreasing the quadrature flux as much as possible.

The motor is provided with a die cast squirrel cage winding similar to the familiar induction motor. The production of torque during the starting period is identical to that of standard induction motor.

To increase the starting torque and make it comparable with that of a standard induction motor, a number of slots are built into the rotor to carry brass conductors which serve as a squirrel cage starting winding. These synduction motors have efficiency, power factor, and torque figures very nearly equal to a standard induction motor, and they run at synchronous speed at all torques below pull-out torque. Apart from slightly greater sensitivity to voltage fluctuations and slightly lower efficiency, power factor and starting torque values, they operate very satisfactorily at exactly constant speed.

Fig. 1. Francois Cahen of France opens the first session. On the extreme right is Carl Chambers of the United States, and next to him Niels Bohr of Denmark

Fig. 2. Niels Bohr, Nobel prize winner and professor at the University Institute for Theoretical Physics. At his left is Carl Chambers of the U. S. A. directly under the ever-present photograph of Marshal Tito, head of Yugoslav state

Engineers Honor Tesla At Belgrade

Marshal Tito opens International Conference in which 20 nations pay tribute to Tesla, pioneering genius in the field of electricity

By RICHARD H. MORRIS
Editorial Director

and

ANDREW W. KRAMER
Editor
POWER ENGINEERING

NIKOLA TESLA, eccentric genius, prolific inventor and stormy petrel of the pioneer days of electricity, was honored at an international conference in Belgrade on the 100th anniversary of his birth.

Tesla, born in what is now Yugoslavia on July 11, 1856, occupies a high niche in governmental, educational and scientific circles of that country. He was educated at the University of Graz (Austria), emigrated to the United States as a young man and did all his work there. He died in 1943 convinced that his last great project, the transmission of large quantities of electric power through the air, could be accomplished.

Tesla's Accomplishments

There are few phases of electricity that Tesla did not explore. His hundreds of patents serve as authentic source data to credit him as a pioneer in practically all areas of high-and low-tension electricity, communication and remote control.

Probably his most important work was the invention of the rotating field and its application to polyphase synchronous and asynchronous machines and polyphase power transmission. He had barely turned thirty when these developments brought him in conflict with Edison, Thomson and Kelvin, exponents of the then-universal direct current system.

Tesla the inventor and George Westinghouse the promotor joined forces, and succeeded in convincing the J. P. Morgan financial interests to install an a-c generating and transmission system at the new 15,000-hp hydro plant at Niagara Falls.

This death blow to the d-c system, and Tesla's part in the controversy, was related by Dr. Carl Chambers, vice president of the University of Pennsylvania. Dr. Chambers emphasized the fundamental soundness of Tesla's early work by pointing out that the frequency he recommended nearly 70 years ago is still the one being used.

One of Tesla's early and spectacular inventions was the high-voltage Tesla coil. Professor Reginald Kapp of England described Tesla's appearance, lecture and demonstration before the Royal Institute. Always a good showman with a flair for the dramatic, Tesla put on a demonstration which pleased and astonished the contemporary scientists.

Kramer Met Tesla

Oddly enough, considering that Tesla lived until 1943, out of all the engineers, scientists and savants gathered to pay homage to his memory, only Dr. Bohr, Dr. Chambers and Professor Kapp had seen Tesla

from the lecture platform. Of those at the meeting, only Andrew W. Kramer, editor of POWER ENGINEERING, had met Tesla face to face, had seen him at work and was familiar with his laboratory in New York.

All, of course, received a thorough briefing on Tesla's activities through the conference and through a special Tesla exhibit. Dr. Muller of Germany quoted from a letter written by Dr. Northrup, of electric furnace fame, on the occasion of Tesla's 75th anniversary, crediting Tesla for inspiration in his own developments.

Technical Sessions

Francois Cahen of the Electricité de France opened the first technical session and introduced Niels Bohr of Denmark, professor at the Institute for Theoretical Physics, Nobel Prize winner and father of present day nuclear physics, as the first speaker. Sir Arthur Fleming of England reviewed Tesla's contribution to electrical engineering and Dr. Dunsheath, president of the International Electrotechnical Commission, announced the recent adoption by the I.E.C. of the TESLA as the unit of flux density.

All together, 18 papers representing 10 countries were presented and a total of 55 foreign delegates from 20 countries were listed in the directory. Roughly a third of the papers and delegates were from the Communist bloc represented by Russia, Red China, Czechoslovakia, Hungary, Poland and Bulgaria.

Tesla's niche in Yugoslav Hall of Fame is well indicated by the fact that Marshall Tito personally received the delegates at the opening session while flags were waving for the Nasser-Nehru conference. Vice-president Svetozar Vickmanovic-Tempo presided at the final reception.

The vice president, formerly Minister of Mines and now in charge of National Economics, with two of his aides as interpreters, ate dinner at the table with Niels Bohr, Dick Morris and Ljubomir Barbaric of the Commission Nationale d'Energic Nucleare.

Yugoslavia's Power Resources

Thoroughly familiar with the potential resources of the country and the need for outside development capital, the vice-president speaks eloquently of the country's future through the export of electric power, copper and aluminum. Apparently great reliance is being placed on an immense hydroelectric construction program currently under way as part of the United States economic aid program.

This Tesla conference, financed by the government, was arranged by the Universities of Belgrad, Zagreb and Ljubljana with the co-operation of the electric power commission of the country and the Institute "Boris Kedric" for nuclear studies.

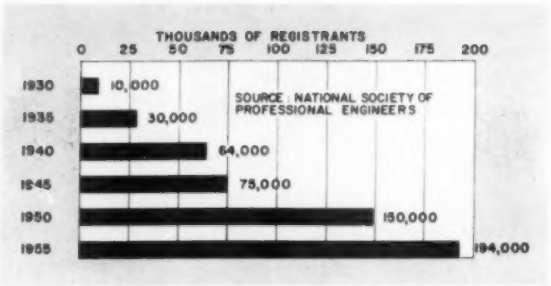
Fig. 3. Dr. Carl Chambers, Univ. of Penn., works out program kinks with Prof. Damjanovic of Univ. of Belgrade, the general secretary of the Tesla Committee

Fig. 4. An international quartet. Dick Morris (left) discusses the Asian hydro situation with Prof. Chu of Habrin, Prof. Alekseev of Leningrad and Dr. Rao of India. Statue is the national hero Vuk Karadzic, who formulated the Serbian alphabet

Fig. 5. Andy Kramer (left) talking to Sir Arthur Fleming (center) about the latter's trip to Chicago AIEE meeting

Fig. 6. L. Barbaric, Yugoslav Nat'l. Nuclear Energy Comm., (left) with Dr. Thacker, a research director of India

Should YOU Become a Registered Engineer?



Bar chart shows growth of number of registered professional engineers in United States between the years 1930 and 1955

By J. D. CONSTANCE

LEGAL REGISTRATION of professional engineers has gone far beyond theory — it is established fact, and here to stay. Because the pioneers of the registration movement had the vision and strong belief and conviction that it represented an indispensable forward step of progress in the profession, because they overcame complacency and disparagement, prejudice and misunderstanding, secret opposition and open antagonism, engineers' registration has become law in every state and territorial possession enacting statutes governing the practice of engineering by individuals.

About 25 years ago, the number of registered engineers was comparatively small. In 1930, there were only 10,000 engineers possessing legal status in the United States. Today we have close to 200,000 registered professional engineers, and this number is increasing rapidly each year. The bar chart above gives a concise pictorial representation of the rapid strides made by this movement. As licensing procedures are strengthened and simplified, and more engineers become aware of the long range benefits of registration and learn how to go about it, the practice of seeking and obtaining licensure will become more widespread.

Service to Public

What are some of the effects of engineers' registration? They are many and varied, with changes taking place continually. We must look upon these effects from the long range point of view in matters of service to the public, acceptance by the public, and recognition by the public. Only thus can an increase in the public's respect for the engineering profession take place.

Responsibility to the public, which is implicit in our state registration laws, is focusing the attention of the practicing engineer on his "profession", and a further effect is to bind closer together all technical branches of engineering through these common requirements. Thus, to the public, the engineering profession can present one common front, one profession. Practically every design, every operation, and every process undertaken by engineers has public implications. If the engineer builds a bridge, designs a dynamo, constructs a steam turbine, or develops a process, he must have the safety and well being of the user, the ultimate consumer, the public, uppermost in his mind. If he builds a water supply system, installs an air conditioning system, or lights a building, the public's health and safety are involved. It should be evident that engineering must be regulated by the state — and comes under the police powers of the various states — to protect the public.

Protection of Title

One way that regulation is achieved is by protecting the use of the title *engineer*. This method has been declared constitutional by our state courts and is followed rigorously by our registration boards and national and state societies. Without registration laws, there would be no way to stop a "legal" practice of engineering by the non-engineer. The misappropriation and abuse of the designation *engineer* is being checked at every turn, and the incompetent and unworthy are halted in their attempts to become registered by the established requirements of experience and examination by our state examining boards.

Without registration laws, the engineer would have been restricted in his established right to practice his profession. In the early days of the registration movement, legislation sponsored by architects would have eliminated or subordinated the engineer in the structural field. It is a matter of record that physicians endeavored to monoplize the sanitary field, and that accountants sought to exclude others from making financial reports. The pioneers of engineers' registration fought off legislation proposed by lawyers to deprive engineers of the right to prepare contract documents and to engage in arbitration proceedings. Even real estate brokers endeavored to monoplize the right of engineers to make appraisals.

Naturally, the esteem and prestige many outstanding engineers bring to the engineering profession, as well as that which is inherent in the profession, attract many, some of whom are qualified and some of whom are not, but who want to use the title *engineer*. These people may be good citizens and neighbors, but many are not in possession of adequate technical knowledge. For instance, there are on record amusing — but potentially dangerous — examples of interesting "new" concepts of physical phenomena put forth by such untrained people. From one of them we learn that the flow of current in an alternating circuit is restricted by something called "impotence." From another comes the thought that moment of inertia of a structural section is a matter of momentum, "or flywheel effect." Others state that modulus of elasticity and section modulus are one and the same, that bending moment is that instant when a beam bends.

It is because of these far-fetched notions, the sources from which they spring, and the dangerous potentialities linked thereto, that it is necessary to have legal minimum standards for those who would practice engineering by regulating the actual practice of the profession.

Technical Development Improved

Another effect of registration is that the technical development of the individual engineer is being improved. The influence of engineers' registration, and the need to meet its requirements, inaugurated programs of accrediting engineering schools and colleges, which in turn raised the standards of engineering education in such matters as improved curricula, quality of teaching, educational plant, and equipment.

Before engineers' registration, most engineers were so-called self-made men. They learned to do their job through the school of hard knocks and experience — and good engineers many of these men became. To this day, we often get the impression that engineers of the older school belittled a formal education. However, with changing times and through the effective instrumentality of engineers' registration, professional education, graduate study, and advanced degrees have now become pretty much the rule. Nevertheless, the gates to registration have not been barred to the man who has not had the ad-

vantages of a formal education; he is provided with the same opportunity as an engineering college graduate to become registered by taking the same written examination. In many instances, our various state boards have granted the privilege of an oral interview and licensure without written examination to many engineers "who came up the hard way".

Most of the state licensing laws require an experience period or "internship" after the completion of undergraduate studies together with an examination attesting to the adequacy of this experience. Graduation from an accredited high school is the basic requirement for qualification in most states. Thus, the high school graduate who enters directly into industry should note carefully the course of his career so he may derive the greatest benefit from his experience in order to qualify for licensure when the time arrives. Through the influence of engineers' registration, the high school graduate, and the engineering school graduate, too, look to industry for encouragement and means for professional development and progress on the job.

Industry is taking this opportunity in stride and is moving beyond the regular indoctrination programs and cadet engineer courses toward providing the young engineer with the means for progression to more important work and greater responsibility on the job. Many industrial concerns have genuine interest in the professional development of their engineers, and have adopted a forward position regarding the registration of their engineering personnel. A large percentage of these concerns are sending men to refresher courses under university extension sponsorship, or are providing similar instruction within their organization for company personnel, entirely from company funds.

Some companies are insisting that their cadet engineers obtain preliminary or Engineer-in-Training Certificates, if not upon graduation, at least shortly after entering their employ. Such recognition adds considerably to the effects of engineers' registration.

Industrial Trend

There is a trend in industry today which sanctions the policy of recognizing that the title "engineer" be reserved solely for one so qualified by registration. All industry is becoming more alert to the desirability of having registered engineers in its employ. Such a policy has definite public appeal and affords some protection to the organization. A registered professional engineer in charge of design is good insurance against possible charges of criminal negligence should equipment — from electric toasters to bridges — cause injury or loss of life and property.

Registration creates a definite recognition of the professional status of engineering, and also promotes a higher standard of engineering. It is continuing to give the engineering profession a higher place in the public's esteem, which was lacking in the past. Registration does not organize for anything, but it does have a profound tendency to make engineers think of themselves as a unified group. Registration helps to improve the quality of engineering, although it must be here and now recognized that it is only a minimum requirement. Registration does not make the engineer; it can only attest to his recognition by the state after due examination by his board of examiners.

One of the most outstanding effects of engineers' registration is the legal status it gives engineering. A number of court cases show that a contract to do engineering work is not legal unless the engineer is registered. Thus, a fee cannot be lawfully collected by a non-registered engineer. Expert engineering testimony is not acceptable in many instances in the courts unless the witness is registered. More and more states are requiring the filing of mechanical plans in addition to structural plans with local, city, and town governments. The general theme is that licensing of engineers is necessary for the welfare, safety, and well-being of the public.

Sweden Plans Expansion of High-Voltage Power Line

INTERESTING account of the developments in high-voltage transmission in Sweden is given by Åke Rusck, head of the Swedish State Power Board, in Issue No. 12 of the Board's blue-white series of pamphlets in English. Dealing with the 380-kv a-c network — which was first energized in 1952 and which will comprise 1,900 miles of line in 1958 — and the 100-kv a-c submarine line to the island of Gotland put into operation in 1954, Mr. Rusck discusses how far Sweden is likely to go in high-voltage transmission.

"If, when we planned the present 380-kv system, we had had the knowledge we possess now, I believe we should have chosen a higher voltage, probably 450 kv," Rusck says. "The insulation level of the present 380-kv lines is a little on the conservative side and will allow an increase of the voltage to 500 kv when internal excess voltages have been reduced. In order to avoid radio interference, it will then be necessary to add a third conductor in each phase of the lines."

The present transformers must be rewound or supplemented with booster transformers. One solution would be to use 450 kv at the transmitting end in the north of the country — where the power stations are situated — and let the voltage gradually drop to 400 kv at the receiving end in the south. The matter is now being thoroughly studied and the possibility is not excluded that the voltage of the present 400-kv system will be raised to the 450–500-kv level, at least in some parts of the system.

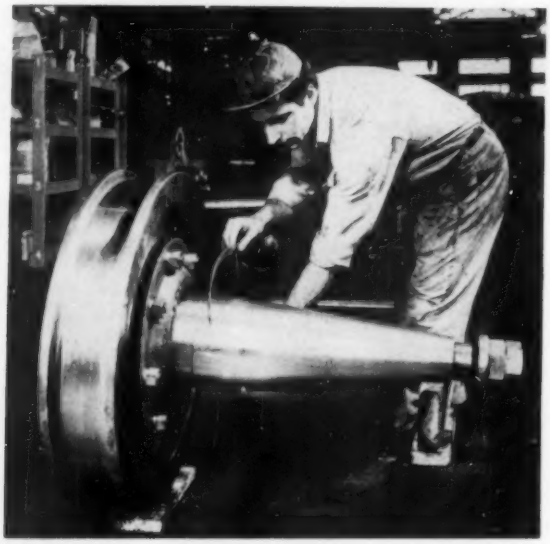
At the same time investigations are proceeding concerning a new system with a considerably higher voltage, and it has been found that a voltage of about 650 kv is probably the highest that can come into question. A 650-kv line using four bundled conductors will have a transmission capacity of about 2000 mw with series capacitor compensation. With the four 380-kv lines running from north to south which will be in service in 1960, two or three 650-kv lines would be sufficient for all power transmission in Sweden in the future.

Another possibility would be to use extra high voltage d-c. Development work is proceeding in order to provide ionic valves for a higher voltage and a larger capacity than the valves used in the 100-kv Gotland transmission, and the prospects seem favorable. Calculations are now being made for ± 400 kv. Such a line would have about the same transmission capacity as the 650-kv a-c line, or nearly 2000 mw. It is impossible at present to offer any figures for comparison; a-c and d-c transmission each has its own special advantages and a final solution will require very careful economic and technical comparison.

"I am not quite sure that we really need a new super-super system," Rusck said. Sweden's potential hydroelectric resources in the northern part of the country have been recalculated, and the figure is about twice as high as when the 380-kv system was decided upon. On the other hand, the transmitting capacity of a 380-kv line has been increased by using series capacitors. Furthermore, the load is increasing in the northern districts, and in 10–20 years nuclear power plants may take care of some of the load in the southern regions.

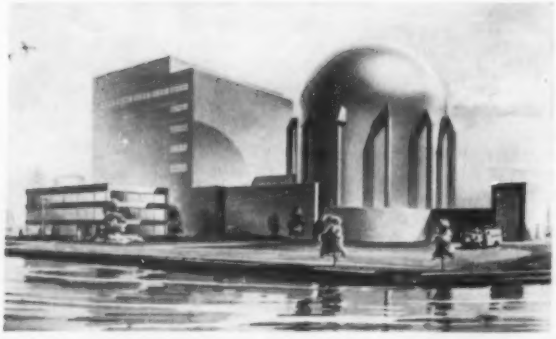
WOULD YOU LIKE TEAR SHEETS?

Readers wanting tear sheets of any article appearing in the issue for their personal file may obtain them by indicating the item desired on one of the post cards appearing in this issue—Editors.



Spindles for the St. Lawrence are these tapered roller units plus wheels being built by Baldwin-Lima-Hamilton for the spillway gates of Long Sault Dam in the seaway. Heat-treated nickel alloy was used here

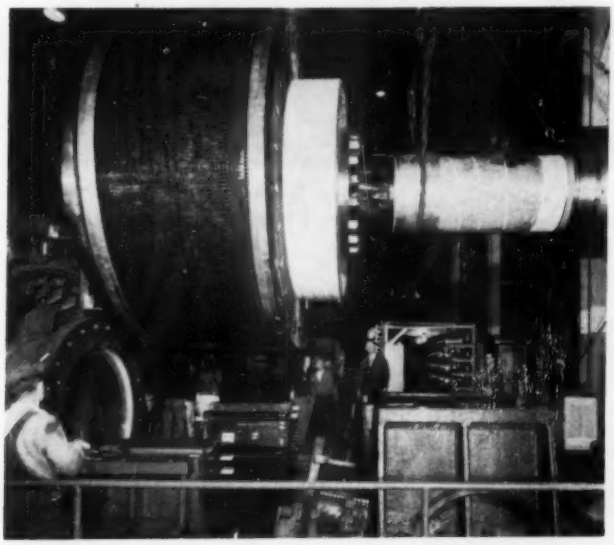
Man Meets Squirrel on rural distribution transformer. A new G-E transformer line and bushing guard protects squirrel or bird from shorting circuit and prevents costly outages



Artist's Drawing of Michigan's first atomic-electric generating station. It will be known as the Enrico Fermi Atomic Power Plant. Initial station capacity will be 150,000 kw

Tempest in a Teapot. Here's a view of the heavy stainless steel core of the first nuclear reactor built for private industrial research—a 50,000-watt unit by Atomics International for research use at Chicago's Illinois Institute of Technology

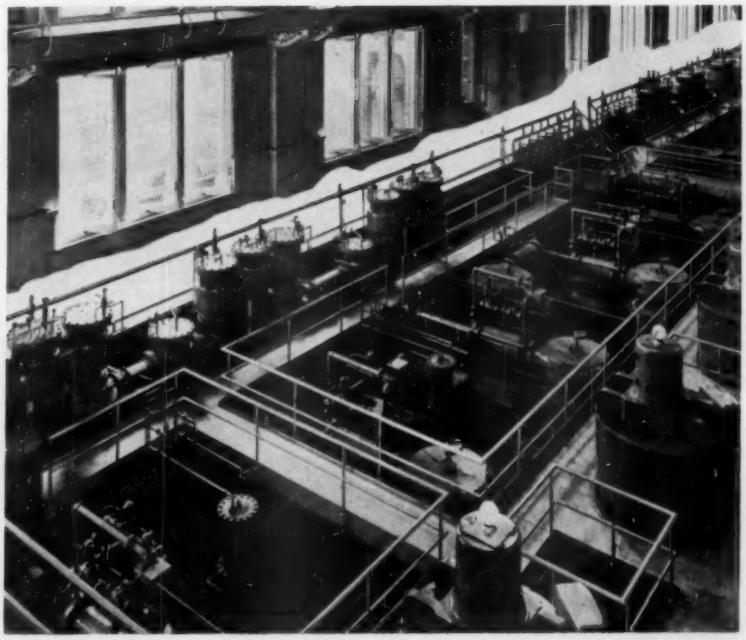
POWER ENGINEERING'S NEWS REEL



Record Downtime of only four days was chalked up in replacing armature and one-half set of field coils on this 7000-hp motor at Geneva Works of U. S. Steel. Prefabrication and preassembly of major parts by GE helped speed the job

Whopper of a Weldment is this 98-ton base section for low-pressure element of a 300,000-kw turbine generator built by Allis-Chalmers Mfg. Co. for Detroit Edison's River Rouge plant

Water Fall of Fire from new magnetic powder by Westinghouse for more powerful permanent magnets. New product 10 times harder to demagnetize



Automatic 16-In. Valves, 28 of them, are used in the Bryant Street Pumping Station in Washington, D. C., to control excess distribution flow. Made by Golden-Anderson, these spillage valves are set at any predetermined pressure

Fig. 1. Towboats with barges like these haul coal from mine upriver to unloading docks for transference to motor trucks

Fig. 2. Coal barged from mines like that in Fig. 1 reach O. H. Hutchings Station of Dayton P&L by railroad and truck

Barges and Trucks Aid Utility During

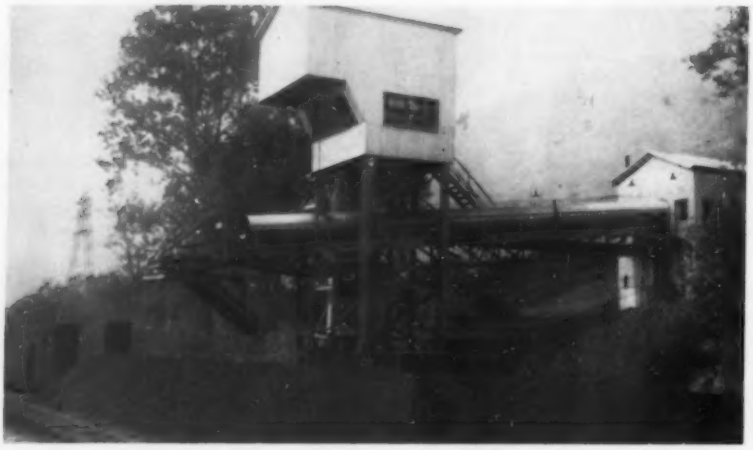


Fig. 3. Barge loading dock on Kanawha River in West Virginia. From similar docks along river, coal is barged into Ohio River for transhipment to trucks

We acknowledge with thanks our debt to the following companies for permission to use their photographs: Dayton Power & Light Co., Figs. 2 and 7; Raymond City Coal and Transportation Co., Figs. 1, 4, 5 and 6.

Fig. 4. Digger boat unloads coal from barge into transfer hopper on a small float. Lower length of conveyor unit is secured to float so whole assembly rises with flood water. Telescoping arrangement of conveyor permits upper length to over-run lower as required

Fig. 5. Loading 17 tons of coal from silo directly into tandem trailer truck

Emergencies

Logistics of coal supply during rail stoppage was worked out by Dayton P&L with help of barge and truck companies. The author tells how and why plan succeeded

By FRED M. REITER*

COAL IS BEING moved by more different means of transportation than probably any other commercial commodity. It has been transported by man, mule, camel, wagon, canals, river, ocean, rail, truck, conveyor belt, and, soon, by pipe line. Thousands of tons were even hauled by planes during the Berlin air lift.

This article is concerned with one particular movement of coal from the Charleston area of the Kanawha River by barge and towboat to North Bend, Ohio, just west of Cincinnati, and thence by truck to the O. H. Hutchings Station of The Dayton Power and Light Company.

This movement started out as a temporary measure to complement our company's rail coal delivery. At times the shipments by rail were irregular, availability of cars was somewhat uncertain, and during the period of stoppage of deliveries over one railroad, our storage piles shrank to a level considered to be too low should a major emergency occur. It was felt that a completely independent source and mode of transportation would augment our stockpiles and coal deliveries.

Coal was located on the Kanawha River that could be loaded directly into barges from tipples situated on the river side. Other coal companies, such as Raymond City, Amherst, Wyatt, Logan and Kanawha, Airco, Cannelton and Richvein, have their own, or have access to river tipples and loading docks on the Kanawha River in the area of the city of Charleston.

There are several tow and barge transportation companies who haul thousands of tons of coal by barge daily from this area. It was not difficult to arrange for barges and tows from these mines to be moved down the Kanawha and Ohio Rivers to the Cincinnati area.

Mine to River

A modern "coal plant" was recently put into operation at Shrewsbury on the Kanawha River. Long belt conveyors carry the mined coal to two large intermediate storage silos that can hold the output of full 8-hour shifts. This intermediate storage permits their large capacity preparation plant to handle the output of several mine shifts within its own single 8-hour shift operation.

The second conveyor crosses over highways, tracks, etc., in delivering coal to the new preparation plant where the coal is washed, sized, and loaded into rail cars. Other conveyors carry the coal under the storage pile to the river. Figure 4 illustrates the loading of the barges at the river tipple. In this case, coal is delivered by belt.

Coal is delivered to most river tipples by truck as the most flexible means of movement for short hauls from several mines. Several tipples have their coal brought to the river by rail, either privately owned or by commercial roads.

Coal is "weighed" in the barges when they are loaded ready for movement by displacement of the water as the load lowers the barge deeper in the river.† The river towboats now come along and, after dropping off empty barges, pick up the loaded ones for movement down the Kanawha and Ohio Rivers, passing through a series of locks, until they arrive at their designated dock of delivery

A digger bucket does an excellent job of cleaning out the barges. The conveyors carry the coal up to the tipple where it can be crushed, screened to desired sizes and loaded into cars or trucks (Fig. 6). A new boat now being installed will use electric power from the Cincinnati Gas and Electric Company in lieu of the steam of the boat.

Figure 7 shows a bottom pour hopper trailer being unloaded over large 10-in. cast grills into pits for delivery to the bunkers, via the Station conveyor system.

Traffic Safety Stressed

No difficulties have been encountered in the movement of coal by river and truck. The truck drivers received thorough instruction from selected speakers of all groups concerned, including the utility, as well as a series of group lectures by state and municipal police officers on load regulations, bridge, and other limitations, safety, and road courtesy. Accidents were few. Complaints that may have arisen at first from residents dwelling along the highway were resolved satisfactorily. All trucks paid the Ohio state axle-mile tax as well as all fuel and road charges, Federal, state and local. All those concerned with the movement of coal in the operation of our stations — coal handlers, weighmasters, gate guards — found the operation satisfactory. When 50-ft truck scales were added, our stations were completely equipped to handle and weigh the coal delivered to us by truck.

The tonnage of coal delivered by truck and rail directly from the river docks has totaled as high as approximately 30,000 tons in one month. Its percentage of our total monthly procurement of coal was not so large, less than 30 per cent. This coal served to complement our supply, particularly during the emergency periods of railroad strikes, car shortages, freezing weather, and other unusual delaying conditions. All of these occurred during the two years in which coal was received by river and truck.

The trip from the dock at North Bend takes approximately 1½ hours, or a 3-hour turn-around, to our O. H. Hutchings Station, and about 2 hours with a 4-hour turn-around to our F. M. Tait Station. This is an important item in winter, during subzero weather. The coal does not have time to freeze in the 1½ to 2 hour road haul period, so that the coal dumps from the trucks very readily. Rail coal, after 5 days on the road, frequently requires thawing and extra handling in very cold weather, which is not only provoking, but increases unloading costs.

Supply Logistics Improved

These short truck trips also provide better control of the "pipe line" flow of the coal. With a 5-day period in transit by rail from the mines, we must anticipate this lag in any changes that we may desire to make in the rate of delivery of the coal in order to meet changes in power production rates, break-downs in coal handling equipment, or other alterations in the planned consumption of coal. The coal continues to arrive at the normal rate of about 50 cars per day, for a minimum of 5 days after a change is ordered.

When the traffic manager can vary up to 30 per cent of his delivered tonnage within 24 hours, the flow can be controlled with greater ease and smoothness. If the load diminished and plenty of rail coal cars were on hand which had to be unloaded without delay in order to avoid demurrage charges, the trucks provided an excellent medium for reducing the incoming tonnage, enabling us to reduce our cars on track rapidly.

The trucks formed a good means of

† See "How Much Coal in That Barge?", POWER ENGINEERING, July, 1956.

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Fig. 6. Arrangement of portable conveyors and hoppers to move coal from ground storage pile to tipple for transfer to rail cars and trucks; tipple not shown

putting coal into storage. The trucks would run to areas around the perimeter of the stockpile in a pattern laid out for the least effort on the part of our bulldozers and conveying equipment. It is more of a chore to unload rail coal to a single point located at the spout of the storage pile conveyor on top of the pile and move this coal to outer areas by long distance pushing with the bulldozers.

It was planned at the commencement of the trucking operations to run trucks around the clock, with 5 turn-arounds during the 24-hour day. This was changed, when more and larger trucks were placed in this service, to 3 turn-arounds per day, taking approximately 9 hours daylight time for the 45-mile run to Hutchings Station, 2 turn-arounds in about the same time for the 60-mile trip to F. M. Tait Station. When first started, any size of dump trucks was utilized, varying from 6 to 12 tons capacity. These sizes were replaced by 17-ton-capacity hydraulically dumped tractor-trailer trucks with 4 axles. The addition of more trucks of the large size, and of double bottom pour hopper trailers of 25 tons coal capacity enabled us to reduce the hauling to the single shift that occupied the roads only during the day periods. All truck operations were cut off on week-ends and holidays so that the large trucks would not become possible causes of accidents or tragedies. The truck drivers welcomed these days off. These rest periods restored their alertness after a week on the road. The roads were mostly state highways whose two lanes were not too wide in some short sections for the truck drivers to watch out for careless drivers. In fact, the truck drivers ditched several loads of coal in order to avoid accidents that would have resulted from the operations of approaching cars.

At the commencement of our trucking operations, the small trucks were able to drive into the top of the coal pile and place a coating of 3-in. coal around the outside slope of the pile. This means of coating the sides of the pile has been under consideration for some time in order to reduce the loss of fine coal by erosion and washing away in small ravines during heavy rains. Dumping 3-in. coal around the sides by means of these trucks performed this task with minimum cost and effort. It was a natural.

Fig. 7. Specially-built double trailer hopper truck is here unloaded over grill into hoppers for feeding coal into conveyor system; these trucks haul 25 tons

Thousand Tons Per Day

At the peak of these operations there were five trucking companies hauling around 1000 tons of their coal to us per day, in about 25 trucks of from 17 to 25 tons capacity per load. They operated 5 or 5½ days per week. All coal was delivered to our stations f.o.b. our pits at which points it became our property. We had no responsibility in the ownership or operation of any of the trucks.

The movement of coal from the Ohio River docks at North Bend and Cincinnati to our O. H. Hutchings Station by highway trucks was replaced by rail haul shortly before Dec. 1, 1955. The same railroad operates between the Raymond City Coal docks and our power generating stations, so that we can retain the short haul benefits discussed above that had been obtained from the use of the trucks, with the rail movement between the two same points.

We were able to take the heavy coal traffic off the overloaded highways and put it back on the railroad tracks. The railroads are well equipped to handle large tonnages of bulk materials such as coal on their track systems. These systems were designed and built to do this job.

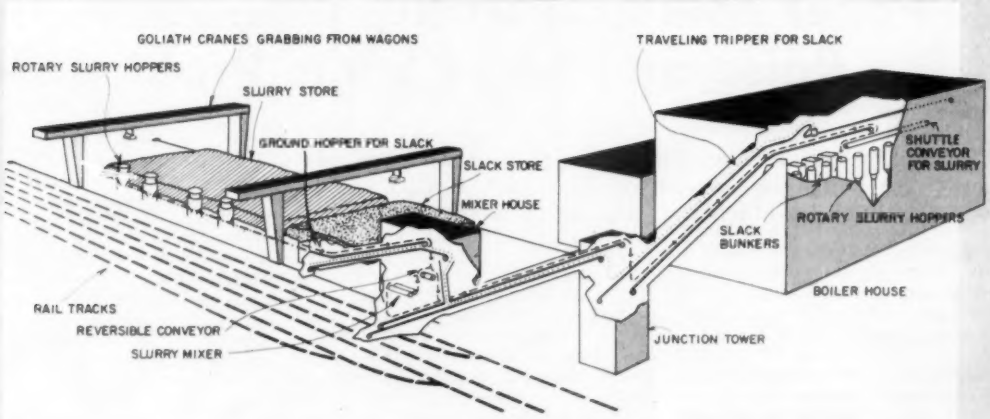

Fig. 1. Sketch of coal handling and storage system at Barony Power Station in southern Scotland. Slack coal and slurry are stored separately; slurry is fed to conveying system by special rotary hoppers designed to cope with its stickiness

This New Steam Plant in Scotland Will Burn Colliery Waste

BARONY POWER Station, now being built in the south of Scotland, has been specifically designed to burn the residual coal slurry that results from highly mechanized mining techniques recently instituted in surrounding collieries.

Although a new coal preparation plant soon to be completed nearby will be able to handle and market a large proportion of the fine coal produced in mining operations, there remain large quantities of residual slurry which is difficult to dispose of; this is the type of fuel the Barony Station will utilize. One of the slurry ponds and the fuel it contains is shown in Fig. 2. When recovered from such ponds, it is known as slurry; when separated from washing effluents by vacuum filtration in the plant now building, it is known as filter cake.

In either case, the coal is irregular in quality and composition, extremely fine, and has a high ash and moisture content. This, together with its content of finely divided clay, makes the fuel very difficult to handle.

Plant capacity has been designed around the quantity of fuel available. Two 30,000-kw turbine generators and four pulverized-fuel fired boilers will be installed. At present, major portion of fuel for the station will be recovered from slurry ponds within a radius of 25 miles, which represents an estimated total quantity in excess of 600,000 tons. When new coal preparation plants go into operation, filter cake from their operations will probably be the main source of coal supply.

The fuel-handling and storage equipment are diagrammed in Fig. 1. Since the slurry is of a very sticky nature, it cannot be discharged from trucks and rail cars by tipping and must be unloaded by grab buckets or especially-designed trucks with an unloading ram. Basis of the design is the need to keep the fuel continuously in motion during the handling process to prevent settling and packing.

Fig. 2. Silt-like coal slurry which Barony Power Station will burn for fuel

Paper Mill and Utility Interconnections Raise and Solve Some Problems—III

In this article the authors discuss disconnection of a mill for power system faults, stabilizing generators by reactive load, circuit breakers vs fuses, and lightning and surge voltage protection

By H. A. ROSE*
and
H. E. SPRINGER†

FREQUENCY OF major voltage disturbances originating in a mill's principal circuits is usually low compared with the utility.[1] One specific case studied gives a ratio of 27/1 over a 23-year period. This is understandable considering the simplicity and very limited extent of a mill's protected distribution system compared with the extensive network of exposed long lines and diversity of loads of the utility.

Faults: Heavy faults at large distance may result in violent voltage and power fluctuations at the mill. If the effects are not isolated or minimized, mill processes will be interfered with. Such disturbances cause one or more following equipment and process outages:

1. Loss of the complete powerhouse.
2. Loss of powerhouse auxiliaries.
3. Breakage of the sheet in the paper machines.
4. Loss of the paper machine auxiliaries.
5. Loss of continuous process drives.

There appears to be little reason for a mill attempting to operate through such voltage and power disturbances if it has in operation sufficient generating capacity to carry the essential load. By means of high speed fault detecting relays and modern circuit breakers it is possible to very quickly isolate the mill on its own generators by opening the tie line circuit breaker.

If the disconnection is effected sufficiently fast, mill processes are not seriously affected. Some voltage and frequency variations will occur while the turbine generators stabilize under the suddenly applied new load conditions. The total fault removal time should be made as short as practical. Values of seven to ten cycles can be realized with present-day standard switchgear, at 15 kv and below.

The fault detecting relays will be connected to instrument transformers of the tie circuit.

If the power delivery voltage is above 15 kw, faster speeds of tie interruption can be realized by opening the transformer low-voltage secondary breaker instead of the more heavily constructed primary breaker.

If the generating units in operation are not capable of assuming the increased load, non-essential load feeders can be automatically dropped, simultaneous with detection of the fault condition. This means the mill load must be departmentalized with sufficient number of feeders.

Required results are most easily and simply obtained with the simple radial type of power distribution system. The circuits should maintain lighting in all departments during the emergency.

High speed (calibrated in cycles) nondirectional induction-type overcurrent relays are adequate for the usual application. These relays are easily adjusted to start operating on any desired value of overcurrent. By means of a lever, the operating time may be adjusted to any value.

Relays: For most applications, settings of one-half division or less should be used to obtain maximum speeds of tie severance. The relays can be substituted in place of standard induction overcurrent types. Initial settings are established by calculation, followed by experimentation as dictated by the results obtained.

Low-energy directional overcurrent and power relays may be justified in specific application, with suitable provisions made for the mill to deliver real and/or reactive power to the utility. Since major faults within the mill occur so infrequently the gains possible by directional relaying may be limited to special cases.

If the tie breaker used for synchronizing is located on the load side of the tie transformer, means must be provided to positively open this breaker whenever the utility supply is interrupted by the operation of protective equipment on the utility system other than the tie breaker. For example, should a utility breaker remote from the mill open, it should be prevented from reclosing until the synchronizing tie breaker is opened. One way to accomplish this is to supervise the utility line on the load side of such a breaker using a voltage sensitive relay arranged to prevent either manual or time delay automatic reclosing until the tie breaker is opened and the intervening line is at zero voltage.

In some cases it may be desirable to prevent any reverse power flow, particularly if the mill generating capacity is substantially less than the normal load. Sensitive directional relays can be used and where these can be made to operate on the magnetizing current of the tie transformer it will assist in opening the tie breaker if the utility supply is interrupted. Relays of this type would be too sensitive for normal switching surges due to synchronizing but the tie breaker control switch can be arranged with contacts to by-pass these relays during switching operations.

It is not always desirable to automatically drop out a fixed number of feeder breakers when the utility supply fails. Some flexibility may be desirable so as to drop out the minimum number of feeders required to reduce the mill load to the capacity of the turbines. A method of accomplishing this is to back up the principal isolation relays with frequency sensitive and time delay relays so as to progressively drop out feeders until a reasonable system frequency is restored.

For best results the turbine governors and extraction mechanisms must operate fast and with minimum tendency to hunt when load is suddenly applied. Generator voltage regulators should also be fast acting with their cross-current compensating circuits adjusted so all machines properly divide reactive load.

After best methods and adjustments have been established for automatically severing the tie, a few circuit-controlling devices about the mill may still malfunction under worst fault conditions. These should be handled individually using applicable correctives such as shunt trip attachments, lower voltage operating coils, time delay undervoltage attachments, latched-in devices, etc.

Speed Regulation: If the speed regulating turbine generator (for isolated mill operation) is equipped with an isochronous speed governor, regulation of mill frequency may be automatically reestablished to maintain electric clocks essentially on time when the tie is interrupted. Isochronous operation must be automatically discontinued at the instant the tie is reestablished to prevent violent load

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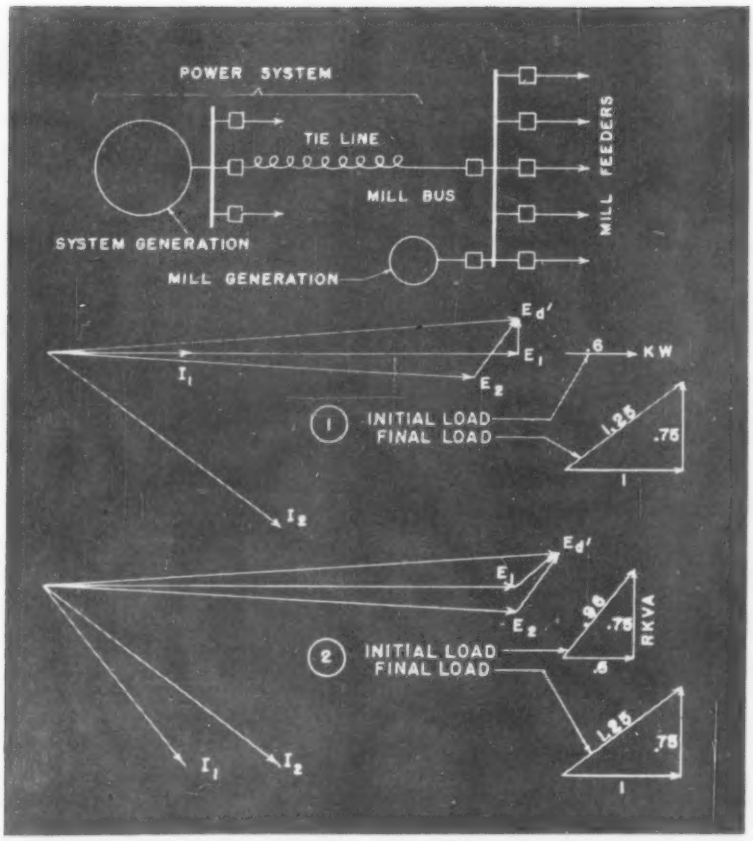

Shows improved voltage stability when generators carry reactive load. 1. Low stability with no reactive load. 2. High stability with 75 per cent reactive load

changes on the turbine for slight changes in utility frequency.

For mill power plants consisting of non-condensing turbines only, such units would normally operate under pressure governing based on maintaining relatively constant extraction and back pressures with electric output subordinated to process steam requirements. System frequency would be established by the utility.

When the utility supply is interrupted, means should be provided to automatically transfer the mill turbine from pressure governing to speed governing so as to maintain the frequency and maximum electric output. This will generally involve blowing steam to atmosphere and is not particularly objectionable unless the utility outages are frequent and of long duration. The turbine would be transferred back to pressure governing when the tie is restored and the turbine again synchronized with the utility.

Stabilizing Mill Generators by Carrying Reactive Load: Usual practice is to allow the utility to carry some portion of the mill's reactive load, as determined by the contract power factor. This may allow the mill to carry more of its own kw load more efficiently with a smaller number of generators on the bus.

If, however, power system fault conditions require rather frequent opening of the tie, improved mill voltage stability can be obtained by increasing the normal lagging reactive load carried by its generators, even to the extent of increasing the number in operation. Such operation may advantageously be extended to where the mill delivers reactive power to the utility while simultaneously drawing real power from it.

The increased excitation required establishes higher orders of flux in the generators which is consumed in generating the lagging current. At the time of fault removal, the excess excitation exists to assist in picking up the mill's total kva load with minimum disturbance and drop in bus voltage. The rate at which the voltage recovers is also improved.

The amount of over-excitation required for most satisfactory results depends on the average kw load the generators are carrying prior to the fault, and the power factor of the mill load to be assumed. An approximate maximum excitation value would be that corresponding to the total kw and kvar load to be assumed.

Chart above partially illustrates the increased stability obtained for assumed initial and final generator kva loadings of 60 per cent and 96 per cent. In the first case, the utility supplies all the mill reactive with the generators operating at unity power factor. In the second case, the generators are carrying the mill reactive plus a portion of the system reactive at 62.5 per cent power factor.

The improved voltage stability is indicated by the relative lengths of vectors E_1 and E_2. In both cases, the mill load is 100 per cent kw, 125 per cent kva at 80 per cent pf in per cent of generator rating. The usual mill will have better than 80 per cent pf.

When new turbine generators are to be purchased, consideration should be given to ordering an oversized (next higher rating) generator. Standard industrial turbine generator units (10,000 kw and smaller) are rated 100 per cent kw at 80 per cent pf, of which the turbine is capable of driving the generator at its full kva rating at 100 per cent pf or 125 per cent kw. The turbine is therefore essentially capable of supplying the full power needs of the next larger generator for operation at 100 per cent kw load and 80 per cent pf.

Oversized generators, powered by normal capacity turbines, still further improve mill voltage stability when the power tie is broken. The oversized generator may make it possible to operate with fewer generating units in operation and at considerable saving in fuel. Under certain operating conditions extraction and back-pressure turbines in pulp mill process may be capable of exceeding the normal guaranteed kw output capability, which may still further justify the increased cost of an oversized generator.

Circuit Breaker Versus the Fused Power Tie: When the supply voltage is above 15 kv, the cost of a primary circuit breaker introduces the lower cost alternative of high voltage power fuses. Fuses have the single advantage of lower first cost. They possess decided disadvantages:

1. A blown fuse subjects the entire mill to single-phase operation which endangers operation of the mass of electrical equipment.
2. A fused tie requires that means be provided to detect blown fuse operation and open a principal secondary circuit breaker to relieve the mill from the hazards of single-phase operation.
3. If the mill has generators of limited capacity, detection of single-phase operation may be difficult and unreliable.
4. Continued unbalanced load current operation, resulting from a blown fuse may dangerously overheat the mill's turbine generators.[2,6]
5. A retained single-phase short circuit resulting from improper fuse operation can in a matter of seconds seriously damage the rotors of any of the mill's generators.[3]
6. Blowing prime circuit fuses constitutes a nuisance to mill operation

which is usually solved by installing oversize fuse elements without concern over the loss in equipment protection that may result.

7. Restoration of service will take longer and be more hazardous.

8. The engine room operator is deprived of direct control of the high tension circuit in emergencies.

In general, the use of fuses in a major power tie to a mill with generators increases the general level of protection required for all mill equipment. The cost and complication of the additional protective apparatus and the increased mantenance required will seldom balance the anticipated savings.

Many mills have sufficient qualified personnel to maintain the more elaborate systems of equipment protection. However, the system with the simplest forms of relay protection and minimum number of protective devices will contribute more to continuity of service than the system with more elaborate forms of protection which are not properly understood or maintained.

Fuses may properly be used in power ties to small mills that do not operate generators in parallel with the system, but their use will always be attended by some of the disadvantages listed above.

Lightning and Surge Voltage Protection: Self-contained mill power systems without exposed lines may not require lightning protection, particularly if located in a low isoceraunic level region.

A utility power tie imposes the necessity for lightning protection. Lightning and other power system surges will be transmitted to the mill in proportion to the system exposure. Such surges are transmitted even through transformers and are a hazard to apparatus of low voltage-impulse level such as generators, motors, cables, and switchgear.

In general, station type lightning arresters are justified to provide the required degree of protection for the large investment involved.

In addition to lightning arresters for the incoming line, surge protective apparatus[4,5] should be provided on the principal power generation and distribution busses of the mill.

Conclusions: Interconnecting large pulp and paper mills with utility power systems presents many technical problems. It is important to know in advance that such problems exist so arrangements can be made for their proper solution. The problems will involve the utility's interconnection and the mill's own generating plant and power distribution system. These problems must be adequately solved if the mill's source of power supply is to operate reliably and safely.[7]

The following are some of the more important problems that are usually encountered:

1. Determination of the most economical form of power contract and the amount of power to be purchased.

2. Anticipation and provision for adequate tie transformer station capacity to meet future purchased power requirements.

3. Modifications in the mill's engine room switchgear and main bus circuitry to provide for its safe operation.

4. Provision for control of purchased power by means of the mill's turbine generators.

5. Provision for adjustment or control of reactive load in the tie circuit by means of suitable taps on the interconnecting transformer.

6. Provisions for disconnecting the tie circuit with minimum loss in mill production in the event of outages and faults in the utility system.

7. Provision for adequate lightning and surge voltage protective equipment for the incoming line and the mill's generator bus.

8. Appreciation of the need and provision for adequate funds to make the interconnection as it should be made.

The above material was adapted and specially rewritten for POWER ENGINEERING by the authors from their AIEE paper.

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Why a Transformer Bank Failed

By C. O. VON DANNENBERG

THE MODERN TRANSFORMER has reached such a degree of perfection with its ruggedness and efficiency that trouble-free service is taken for granted. With production in the millions of units annually, every possible improvement and refinement in design and construction have been sought after.

Many engineers, however, do not realize just how close to saturation many modern transformers are designed, and how vital it is to operate them as close as possible to rated voltage. The following experience will emphasize the disastrous results of departing from rated voltage.

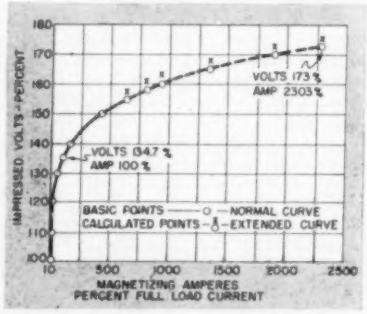
The details given below concern a 3-phase bank, made up from three single-phase units with a supply from a 4160 v, 3-phase, 4-wire system. The whole installation, owned by the customer, had been installed by a contractor supposedly qualified to do the work, but who from his own admission later thought that the high voltage side should be connected in "delta." The result when the supply breaker was first closed can be imagined, with each 2400 v winding having impressed upon it 173 per cent of its normal rated voltage, which wrecked the whole bank completely.

The writer was approached by the contractor, who attempted to evade his responsibility by contending that the transformer units were faulty in design and construction. While this contention seemed absurd and unfounded, an investigation was conducted to get an idea of the shock to which the transformers might have been subjected. The results, as shown below, were quite startling.

Figure 1 shows the relation between impressed voltage and magnetizing current for the type of transformer being considered. Data from a prominent manufacturer confirms the values up to 150 per cent of normal voltage, and points for the curve beyond 150 per cent were calculated to take it up to the 173 per cent of normal voltage to which the transformers were subjected.

It can be seen from the curve that due to saturation, the magnetizing current at 173 per cent normal voltage reaches the enormous value of 2303 per cent of normal full load current, which certainly accounts for the complete destruction of the bank and also emphasizes the necessity of operating the modern transformer as close as practicable to its rated voltage.

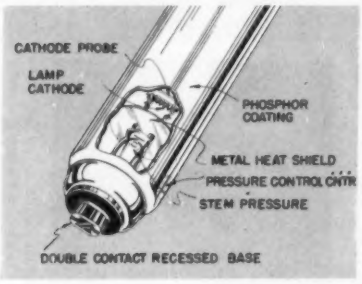
It is of interest to note that at approximately 135 per cent of rated voltage the magnetizing current equals 100 per cent or full load current value.



This curve shows how excess voltage gives very heavy magnetizing current

New Fluorescent Gives 2½ Times More Light

NEW TYPE of fluorescent lamp which provides 2½ times as much light as the conventional models now available was recently announced by Sylvania Electric Products, Inc. Features of the new lamp, designated as type VHO (very high output), include rapid starting, continuous filament heating for good electronic emission, a "pressure control center"



Cutaway view shows end construction of new VHO fluorescent lamp with neon gas

in the tube itself for best operation at all reasonable ambient temperatures, and the use of neon gas instead of the commonly-used argon.

VHO lamps are 1½-in. in diameter, considered to be the optimum size — and they are now manufactured in 4- and 8-ft lengths rated at 100 watts, 6200 lumens, and 200 watts, 13,250 lumens, respectively. Sizewise, they are interchangeable with current lamps of similar size, but different ballasts are required. Fixtures and luminaires to utilize VHO lamps will undoubtedly be on the market in short order. In some locations, fluorescent lamp holders of present design do not have sufficient heat-dissipating capacity to meet the requirements of the new high-output models. The lamps themselves will be commercially available in a few months. Samples and data are available now to ballast and fixture manufacturers for design purposes.

1250-hp Canned Pump

ONE OF THE LARGEST canned-motor pumps ever built has just been completed by General Electric. The motor is rated at 1250 hp, and both pump and motor form an integral unit within the sealed casing.

The pump will be used for pumping radioactive coolant water, and tests made with a mass spectrometer have shown leakage to be nil.

The unit is ten ft high by four ft diam at the base and weighs 30,000 lb. It will operate at pressure up to 2500 psi and temperatures up to 650 F.

ASME Members Discuss Engineering Manpower Shortage

ENGINEERS have themselves provided a set of answers to questions plaguing educators, industrialists and military planners as a result of the current shortage of engineering talent. They suggested changes in high school and college educational programs and outlined immediate steps that they thought should be taken by industry. The answers came from members of ASME at the recent semi-annual meeting.

In suggesting immediate steps that might be taken by industry to relieve the shortage, 34 per cent of the 220 engineers responding said that engineers now in industry should be relieved of routine work that could be done by less-highly-trained technicians. Another 26 per cent suggested higher salaries for engineers.

Other answers included 22 per cent who suggested a better job of selling the profession to young people, 6 per cent who said that they do not believe a shortage exists, and 3 per cent who said the problem would be solved by the laws of supply and demand or operation of the free-enterprise system.

Another very significant comment on the current shortage of scientists and engineers was made by Dr. Alan T. Waterman, Director, National Science Foundation, in a recent address before the Air Force Association.

After reviewing the manpower needs of the coming jet age, he concluded:

"Finally, there is a positive side to the whole matter which has been excellently stated in the Interim Report of the Joint Committee on Atomic Energy's Subcommittee on Research and Development. Commenting on the shortage of scientific and engineering manpower, the report notes:

"It is important to recognize at the outset that these serious shortages are not a sign of failure but an indication of startling success. A way of life has been created in which the demands made for superior skills in every field have become so tremendous that growth and expansion have become constant elements of the normal pattern. A society has been created in which progress is not simply a matter of occasional spurts and short-term crises. Rapid progress has become a normal part of our national life, and the skilled manpower to keep up with this steadily and rapidly advancing march of progress will be in demand for years to come.' "

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Readers who have already sent in reservations for thousands of copies of the Turbine Overhaul reprint are being notified it is ready. They will receive one free copy; additional copies at prices noted above.

Booster Boiler Solved Our Problem of Heating an Enlarged Building

By FRANK KUMKE*

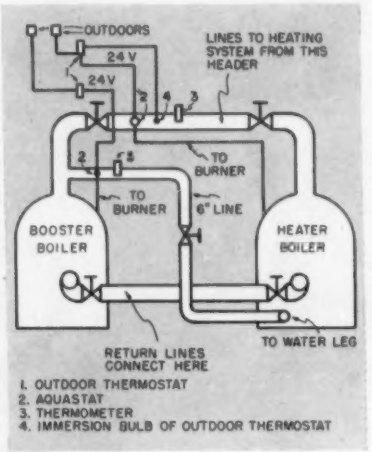
AFTER SEVERAL new wings had been added to the Mary Lanning Memorial Hospital, and another was contemplated, the question very naturally arose as to whether our heating plant could carry the load, since it had not been enlarged along with the rest of the plant.

Our heating system consists of one 50 hp hot water horizontal fire tube boiler and one smaller similar boiler used as a stand-by unit. They are connected and valved at the headers and at the return feed lines, so either boiler can be used independently of the other. The boilers are equipped with combination oil and gas burners, the latter used exclusively with oil for emergency use. Both are operated with automatic controls, including a one-to-one ratio outdoor bulb thermostat that controls the water temperature in the boiler according to the outdoor temperature.

The system is divided into seven zones. Each return line is equipped with a circulating pump governed by a room thermostat for that zone. One pump is on continuous operation for our air conditioner in the surgery department, which takes in 100 per cent fresh air.

We felt that it was impractical to operate both boilers in unison, as any flow restriction variations between the two boilers would create an unbalanced condition.

To solve our problem we used the stand-by unit as a booster or preheater for the larger boiler, as shown in sketch. A 6-in. line was installed from the header of the booster, ahead of the valve, down into the water leg of the larger boiler. This line was electric-welded with sweeping ells to prevent friction loss. We installed a gate valve, thermometer, and an aquastat in this line.



How stand-by boiler is turned into a booster boiler

*Engineer, Mary Lanning Memorial Hospital, Hastings, Nebraska

fold along this line—outside edges toward you

By closing the header valve between the two boilers and the one on the return line into the larger boiler, and opening the valves on the return line of the booster and in the 6-in. line, we circulate the water through the booster into the main boiler.

We discovered that the large boiler would take care of our heating need without the help from the booster except in sub-zero weather. So another outdoor bulb thermostat was installed and connected to the burner valve of the booster in series with the aquastat. By setting this thermostat at zero and the aquastat at 120 deg, with the pilot on at all times, when the outdoor temperature drops below zero the booster automatically goes into operation, pre-heating the return water up to as much as 120 F.

The limit switch on our larger boiler is set at 140 deg. However, the original thermostat with outdoor bulb prevents this high a temperature of boiler water except in below-zero weather. This prevents overheated radiators and pipes, and protects our patients and personnel from injury and burns.

In milder seasons when the booster is not needed we run the return water directly into the large boiler and shut the booster down.

This set-up has proved to be very efficient as well as economical to install and operate. It has been approved by local inspectors and the boiler inspector of a nationally-known insurance company. It has not only taken care of our present expanded needs but assures us ample heat for more additions to our buildings.

How to Repair Damaged Thermal Insulation

WHITE SPUN mineral wool insulating-finishing cement has proved its effectiveness as a material which simplifies the repair of cracked insulation of main boiler breeching. The photographs here were taken at the U. S. Navy Aviation Supply Depot in Philadelphia, and show how the dual-purpose cement made it possible to avoid complete re-insulation of the breeching.

The original insulation was applied some 12 years ago, and consisted of blankets and two ¼-in. layers of conventional finishing cement. Rigid mineral wool block insulation was not applied because of wartime shortages.

Fig. 1. Original insulation in damaged spots was removed right down to metal skin of the breaching

Fig. 2. Heavy gage expanded metal lath was secured to welding studs, and cement troweled on

Figure 1 shows how the damaged portions of the original cement and blanket material were removed, right down to the metal skin of the breeching in some spots. Most of the existing blanket insulation was left intact.

Next, heavy gage expanded metal lath was secured to the welding studs which held the blankets, and new studs were welded to the breeching where necessary. The heavy gage lath provided a base for the subsequent coat of insulating-finishing cement. When pulled tight, the lath gave additional support for the old in-

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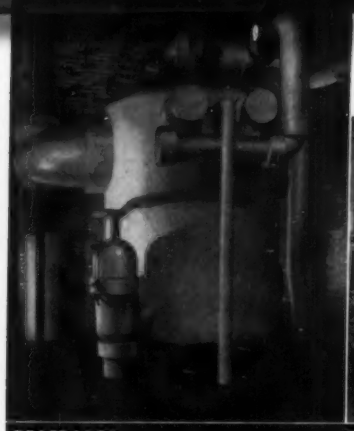
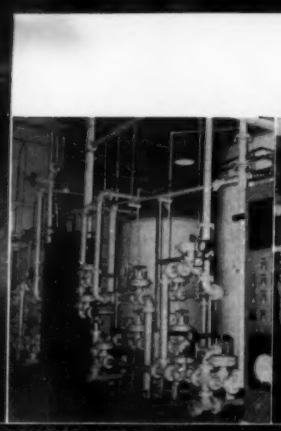
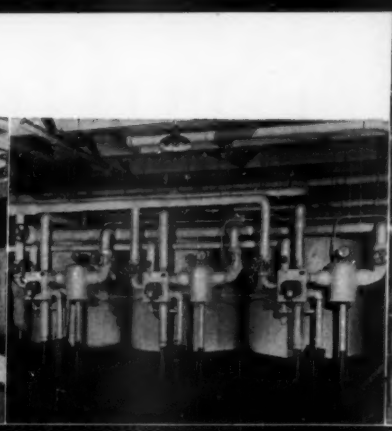


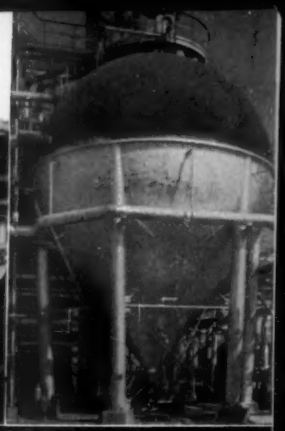
DEAERATOR



DEMINERALIZER



ZEOLITE SOFTENER



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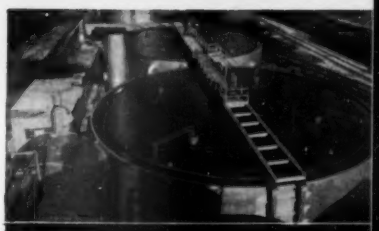

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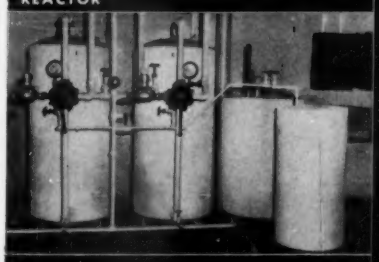
Development of the Cochrane Hydromatic Valve sets a new standard in automatic control for Ion Exchange Processes.

Cochrane's background as heat engineers has also been responsible for the development of steam specialties recognized and used throughout industry today. The C-B Jet Pump improves heat transfer, reduces drying costs with resultant product improvement and usually increases production output.

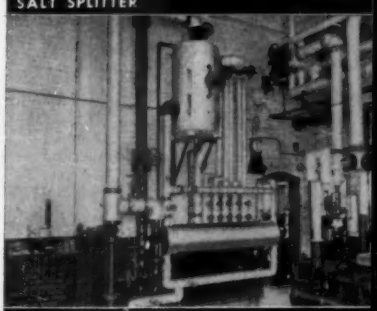
This complete service, available at Cochrane, provides a single responsibility for continuous satisfactory operation of every installation. It is an assurance that guarantees will be met. Why not consult Cochrane?

MULTIPORT RELIEF VALVE



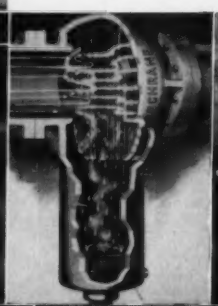
SALT SPLITTER

MULTIPORT DRAINER

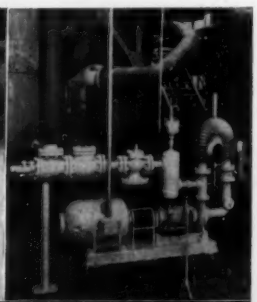


CONTINUOUS BLOW-OFF

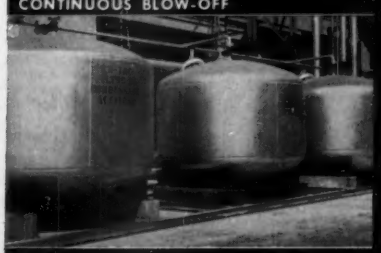
STEAM PURIFIER



OIL SEPARATOR



C-B SYSTEM



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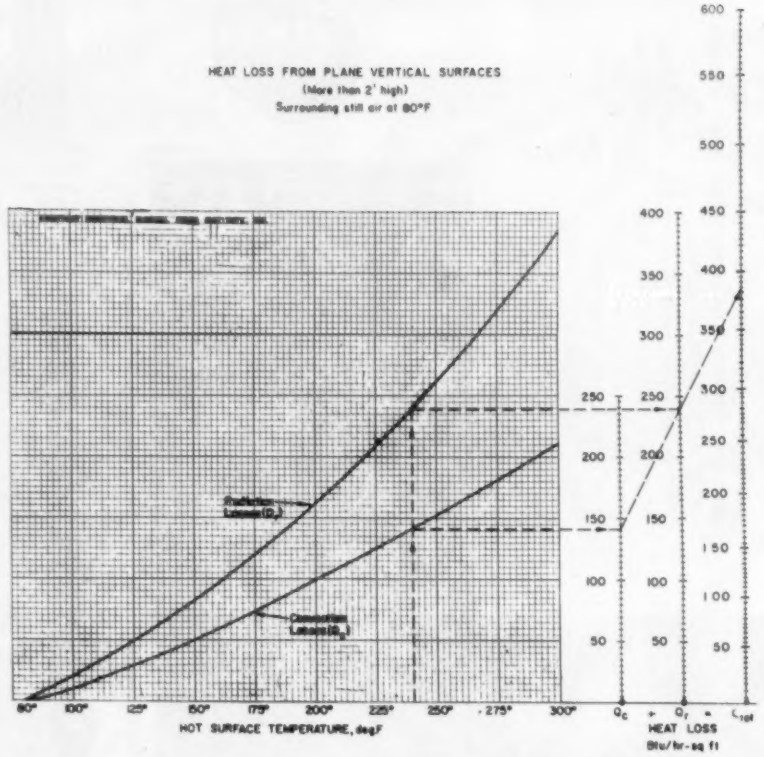
sulation. Corner bead was secured to the lath along the corners of the duct.

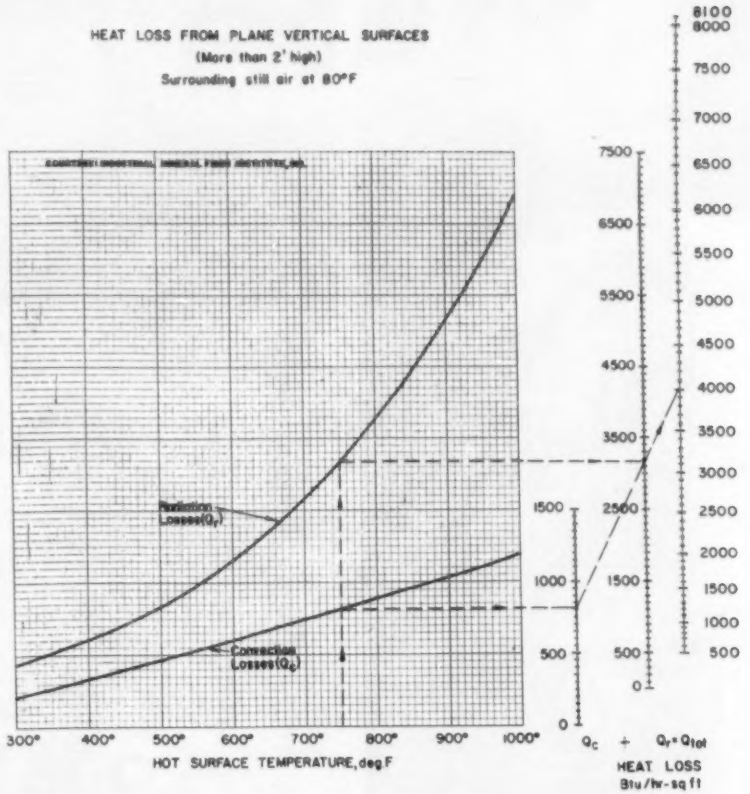
Figure 2 shows how the insulating-finishing cement was applied over the metal until a level, smooth finish was attained. It was necessary to apply the cement in varying thicknesses in order to level the exterior surface. When finished troweled, the cement dried to its characteristic glazed-white finish.

The contractor's report was that the use of this cement speeded completion of the job because it is quick setting (took initial set in 2–3 hours) and fast drying. It was also possible to apply it in thicker layers than conventional finishing cements (up to 1 in. as compared to ¼-in.) without danger of shrinkage cracks.

New Calculator Gives Heat Loss Answers


HEAT LOSS FROM PLANE VERTICAL SURFACES
(More than 2' high)
Surrounding still air at 80°F
Radiation Losses (Q_r)
Convection Losses (Q_c)
80° 100° 125° 150° 175° 200° 225° 250° 275° 300°
HOT SURFACE TEMPERATURE, deg F
Q_c + Q_r = Q_{tot}
HEAT LOSS
Btu/hr-sq ft

fold along this line—outside edges toward you


HEAT LOSS FROM PLANE VERTICAL SURFACES
(More than 2' high)
Surrounding still air at 80°F
Radiation Losses (Q_r)
Convection Losses (Q_c)
300° 400° 500° 600° 700° 800° 900° 1000°
HOT SURFACE TEMPERATURE, deg F
Q_c + Q_r = Q_{tot}
HEAT LOSS
Btu/hr-sq ft

NEW COMBINATION of curves and nomograph developed by the Technical Committee of the Industrial Mineral Fiber Institute, Inc., eliminates time-consuming calculations in determining heat losses from plane vertical surfaces more than two feet high at temperatures to 1000 deg F, assuming a surrounding air of 80 deg F. This calculator gives heat losses due to natural convection and radiation, and gives total losses as well.

To use the calculator, which is given here in two parts, Figs. 1 and 2, enter from the bottom of the curve at the hot surface temperature and proceed upward to the natural convection curve. Mark off the loss due to convection on the Q_c scale to the right. Continue vertically upward from the convection curve to the radiation curve and mark the Q_r scale as before. To find the total heat loss, draw a line through the two marked points and project it to the Qtot scale.

Readers wanting tear sheets of any article appearing in the issue for their personal file may obtain them by indicating the item desired on one of the post cards appearing in this issue—Editors.

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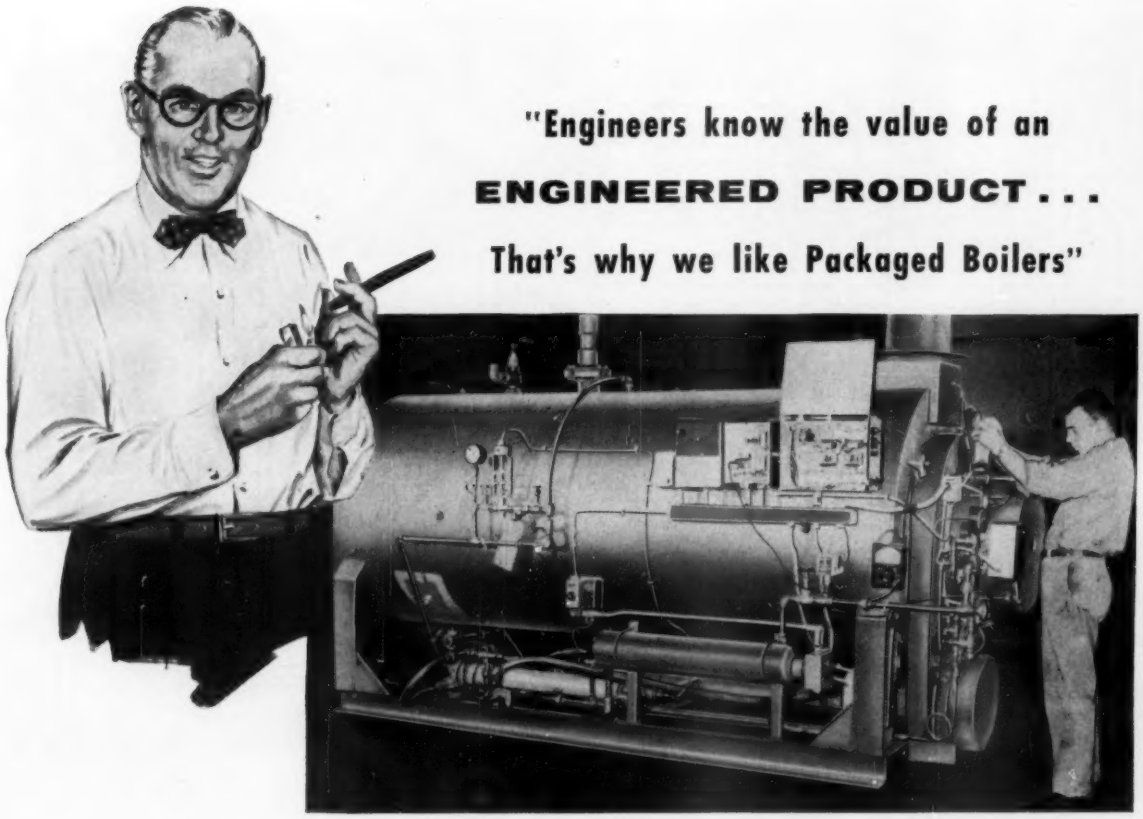

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How to Select Control Batteries for Power Generating Stations

By K. A. VAUGHAN *

POWER GENERATING stations and substations require dependable power sources to operate controls, safety devices, and indicators under widely varying conditions. Control batteries, the usual power source for such equipment, must be large enough to satisfy emergency requirements, yet should not be over-sized and thus unnecessarily increase equipment costs.

Before selecting a control battery the load requirements should be divided into three groups according to the type of load. The customary classifications are: switchgear load, pilot light load, and emergency lighting or power load.

The durations of these three classes of load are generally different — the closing switchgear requires less than a second, pilot lights may require continuous current supply and emergency lighting or power equipment requires current over the expected period of emergency.

Because batteries possess different capacities at different discharge rates, the plates-per-cell requirement for each type of load should be found separately. The total battery size is obtained by adding the plates-per-cell required for all three types of service.

Selecting the number of cells for the control battery is a simple matter, because power station control apparatus has been standardized at either 120 or 240 volts. Most equipment is classified as operating on 120 volts and permits a variation in voltage between 90 and 140 v. A 60-cell control battery normally should be selected for 120 v equipment.

Since the voltage of a battery depends only on the number of cells (each cell contributing 1.75 v when it is considered to be completely discharged) the minimum voltage of a 60-cell battery is 60 (cells) x 1.75 (final voltage) = 105 volts. This is 15 v above the minimum requirement of the equipment. The excess 15 v offsets the IR drop caused by circuit resistance between battery and control equipment.

For equipment classified as operating on 240 v, a 120-cell battery should be selected. Such equipment will function when voltage varies from 180 to 280 v. The 120-cell battery which is not dangerously undercharged will always provide voltages safely within this range.

Switchgear Load

The number of plates per cell needed to supply energy for repeated closing of switchgear is computed from the one-minute battery discharge rate. If more than one switch closes simultaneously, the capacity must be large enough for the combined load. When fewer than 20 circuit breakers are installed it is usually assumed that only one closing operation will occur at a time, although as many as half of the circuit breakers may trip simultaneously.

A much lower current is needed for tripping than for the closing operation. Therefore, it is customary to assume that a battery with enough capacity for closing will have enough capacity for both operations. For safety, both current requirements should be checked and the larger value used when calculating battery size.

A battery that has sufficient capacity for simultaneous closings will also have capacity for repeated closings. Closings never repeat at intervals of less than one or two seconds.

Pilot Light Load

The pilot light load is the total number of lights multiplied by the current drain of each. The time interval during which the pilot load must be carried depends on the installation (attended or unattended stations).

Emergency Lighting Load

If control batteries supply energy for emergency lighting, the total ampere load for the duration of the emergency must be determined. The time generally varies from a few minutes to 12 hours.

Having found ampere values for the three load types, the time periods for which these loads must be carried, the appropriate number of plates-per-cell can be found from curves and other data supplied by the battery manufacturer.

These data for each battery type include: (1) the capacity per positive plate at the one-minute rate, for different sized cells, (2) a curve giving capacity in both amperes and ampere-hours per positive plate for longer discharge rates, and (3) a temperature correction curve.

The temperature correction curve is necessary because battery capacity varies somewhat with the temperature of the battery. Standard capacity curves are for behavior at a standard temperature of 77 F. Above that temperature capacity increases slightly; below it, capacity decreases slightly. The amount

*National Service Manager, Gould-National Batteries, Inc.

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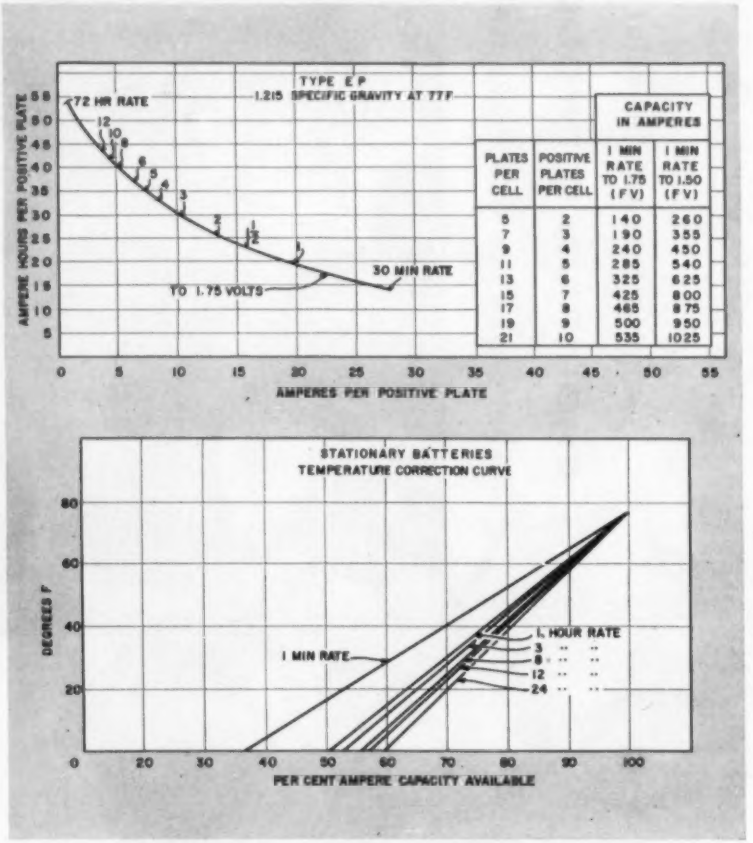

Fig. 1—Above. Tabulation for battery selection, curve of ampere-hours vs amperes per positive plate
Fig. 2—Below. Temperature correction curve for all lead-acid stationary batteries, for selecting battery

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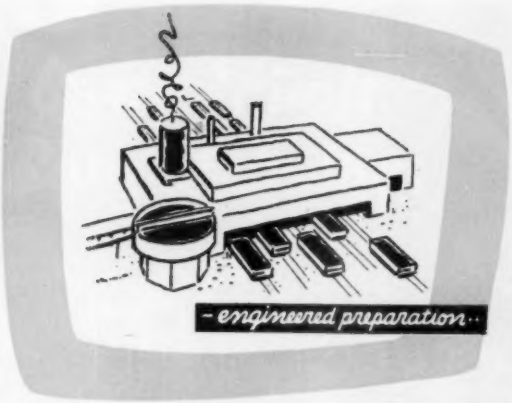
"by land and by sea"



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of this capacity correction depends on the discharge rate — low temperatures affecting the one-minute rate more than the 8-hour rate.

To make the temperature correction, the engineer must, of course, establish the temperature conditions under which the battery will operate. Correction should be based on the lowest ambient temperature of the year. In attended stations (heated) the correction is usually too small to bother with. On the other hand, temperature corrections for unattended stations may become significant if operation is to be safe in winter months.

To find the correct number of positive plates per cell, first use the manufacturer's data for the battery type under consideration and determine (for each load condition) the available ampere capacity per positive plate. Correct each of these values for lowest ambient temperature of service. Divide these ampere capacities (in turn) into the ampere requirements for their corresponding types of load.

Thus you arrive at a calculated number of positive plates necessary to handle each type of load. Add these figures to get a total number of positive plates per cell. If the total shows a fraction greater than 5 per cent of the total figure, increase the number to the next whole number. Otherwise neglect the fraction. Double this whole number and add one to get the proper number of plates (both positive and negative) per cell.

Example

An example will illustrate this method for selecting the proper cell size. Suppose a 60-cell control battery is required to meet the following load conditions at a temperature not lower than 55 F: (1) switchgear requirement — one switch requiring 90 amperes to close; (2) pilot light requirement — one ampere for 8 hours; (3) emergency light requirement — 7 amperes for three hours.

Also assume that a Plate (Type EP) cell is desired. The necessary data for this type of battery are given in Fig. 1. The temperature correction curve for all lead-acid stationary batteries is given in Fig. 2.

Starting with an approximate battery size of 9 plates per cell (4 positive plates) first tackle the *switchgear* load.

From the tabular data in Fig. 1 for one-minute discharge of 1.75 volts, the capacity is seen to be 240 amperes, or 60 amperes per positive plate. And from the one-minute curve on Fig. 2 it is seen that a minimum temperature of 55 F reduces the amperes per plate to 82 per cent.

Thus the available current per positive plate is 60 × 0.82 or 49.2 amperes. Dividing this figure into the 90 amperes required to close one switch, one gets 1.83 positive plates per cell to handle the switchgear load.

Shifting to the *pilot light* requirement (8 hours service) consult the curve of Fig. 1 to ascertain capacity of 5 amperes (40 ampere hours in 8 hours) for the Type EP battery at the 8-hour rate. The 8-hour curve on Fig. 2 shows 87.4 per cent capacity at 55 F. Therefore the available current per positive plate (at the 8-hour rate) is 5 x 0.874 or 4.37 ampere. Dividing this figure into the one ampere requirement for pilot lights, one gets 0.23 plates per cell.

Finally, for the *emergency lighting* load (3 hours of service), one again consults the Type EP curve (Fig. 1) and at the 3-hour rate finds an availability of 10 amperes per positive plate (30 ampere hours in 3 hours). The 3-hour curve on the temperature correction chart (Fig. 2) shows 86.6 per cent capacity at 55 F.

Thus the available current per positive plate (at the 3-hour rate) is 10 × 0.866 or 8.66 amperes. Dividing this figure into the 7 ampere requirement for emergency lighting yields 0.81 positive plates per cell.

The total positive-plates-per-cell for all three loads is therefore 1.83 plus 0.23 plus 0.81 or 2.87 positive plates per cell. The fraction 0.87 exceeds 5 per cent of the total figure. Thus 3 positive plates per cell is correct.

This means that a 7-plate Type EP battery is quite sufficient (even for service at 55 F) and there is no need to specify the 9-plate size from which the calculation began.

We will have extra tear sheets of the Handbook pages beginning with the June issue. If you want an extra copy of any or all of these pages, write the Handbook Editor and we'll send one—as long as supply lasts

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Piped Dry Chemical Approved for Fire Extinguishing System

UNDERWRITERS Laboratories, Inc., has given approval to the dry chemical piped system of fire extinguishment developed by the Ansul Chemical Co. This marks the first time that such a system has been given approval by a recognized agency.

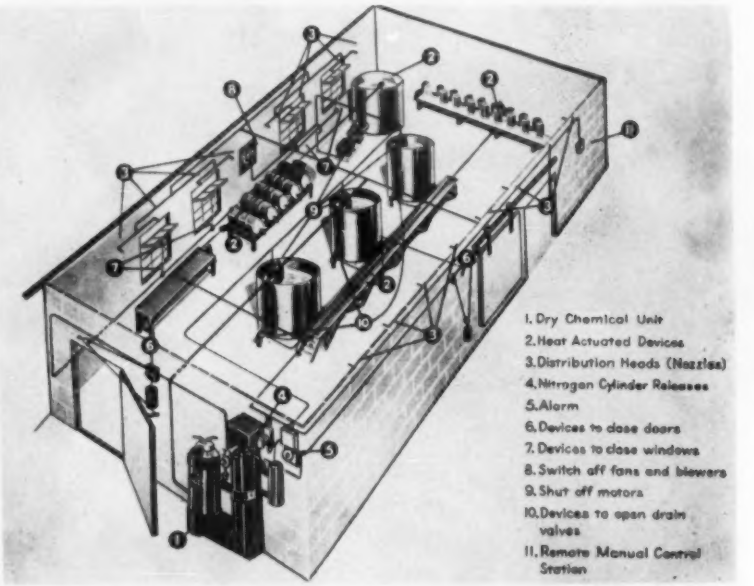
With this system, automatic fire protection is provided against Class B and Class C fire hazards by means of dry chemical, which is conveyed through pipes and expelled in the area surrounding the hazard.

The illustration shows how a paint-mixing room, in which various flammable liquids are stored, would be protected. If a fire should start, a heat-actuated device automatically reports a fire to the nitrogen cylinder release. Windows and doors are automatically closed, fans and motors are shut off, valves are opened and an alarm is sounded. At the same time, dry chemical is expelled through distribution heads in the pipes, and puts out the fire immediately.

This piped system can be adapted for installation at many industrial fire hazards, including paint dip tanks and spray booths, ovens, driers, oil quench tanks, flammable liquid pumping stations, oil storage tanks, flammable liquid storage rooms, asphalt saturators and marine hazards.

By using automatic selector valves, one piped system can protect two or more separate hazards. Dry chemical flows only into the piping that leads to the fire area involved.

For more information, write to the Editor of the Handbook, POWER ENGINEERING.


1. Dry Chemical Unit
2. Heat Actuated Devices
3. Distribution Heads (Nozzles)
4. Nitrogen Cylinder Releases
5. Alarm
6. Devices to close doors
7. Devices to close windows
8. Switch off fans and blowers
9. Shut off motors
10. Devices to open drain valves
11. Remote Manual Control Station

Scheme shows set-up for a paint-mixing room protected by automatic dry chemical piped system

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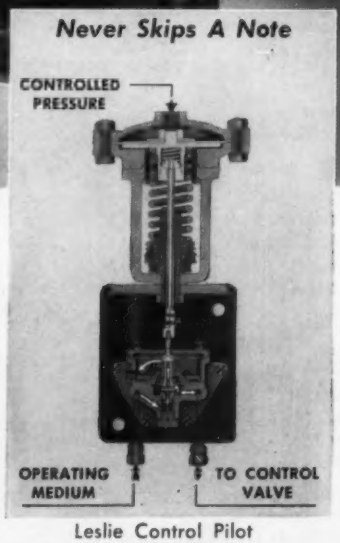
Here's a Quartet of Control Pilots that Sings a Song of Savings



Leslie Control Pilot
Type PDA
Sectional View

NEVER A DISCORDANT NOTE from this quartet - - - they're always in tune - - - each unit doing its part to create 24-hour-a-day harmony. They save time — no personal attention or manual assistance required after they're set. Pressures stay at set point for top efficiency of process equipment in the line. Positive response of pilot and valve assures smooth throttling action within closely held limits.

The same smooth action and accurate control is provided even when extreme reductions are necessary (there are Leslie installations handling reduction of 2150 psi. to 5 psi. in one step!) Responds to pressure deviations as small as .025 psi., depending on pilot range.

For more information on controllers that save maintenance dollars, consult the nearest Leslie Engineer listed in your classified telephone directory under "Valves" or "Regulators". Use this help for economy in temperature and pressure regulation.

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How to Test Discharge Batteries Using Correction Curves

WHEN BATTERIES have been in use several years, a check test is required to determine individual battery condition with accuracy. This is accomplished by a test discharge, a procedure which can be simplified by using the correction curves shown in Figs. 3 and 4.

Curve in Fig. 1 shows the relationship of battery capacity to life expectancy. The test discharge will give battery capacity from which battery life can be determined. As battery capacity approaches 80 per cent, the rate of decrease in capacity is sharper. When capacity falls below 80–85 per cent, it should be watched carefully and plans made to replace it.

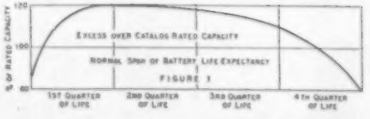


Fig. 1. This curve shows relationship between battery capacity and a battery's life expectancy

Discharge Test Procedure

First the battery is given a normal charge at the usual rate. It is then given an equalizing charge at the finishing rate until there is no increase in specific gravity and all the individual cells are uniform and do not differ from each other by more than 0.020 and none register less than 1.250. The specific gravity of each cell is taken and an average calculated. The average temperature of the electrolyte in the battery is also determined and recorded, as well as the room temperature. As soon as possible after being fully charged, and not more than 16 hours later, the test discharge should be started. The battery is usually discharged at the 6-hour rate, which can be obtained from the name plate on the battery. A 600 amp-hr battery would be discharged at 100 amp for 6 hours.

CAPACITY DISCHARGE TEST DATA SHEET

Battery _____ Mfgr. _____
Battery No. _____ Service Date _____
Used in _____ Cycles to Date _____
Tested by _____ Rated Capacity ____ Amp. Hrs. ___Hr. Rate
Pre-Test Charge ____Hrs. to Max Volts; ____ Amp. Hrs. Charge

Date _____

TEST SUMMARY

Battery delivered _____ Amp. Hrs. at _____Hr. Rate to 1.75 volts per cell average, or _____% of rated capacity.

All readings UNCORRECTED for temperature

	END OF CHARGE			BATTERY DISCHARGE Air. Temp. _____°F. Electrolyte level __" to __"												END READINGS	
			Volts Open	Volts	Volts End of										Final Sp.Gr.	4 Hrs	Later
Cell	Volts	Sp. Gr.	Circuit	Start	1 Hrs	2 Hrs	3 Hrs	4 Hrs	4-1/2	5 Hrs	5-1/2	5-3/4	6 Hrs	6-1/4	Temp.	Sp.Gr.	Temp.
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
Total Volts																	
Rate Amps.																	
Temp. Inside Cell																	

Fig. 2. Suggested form for recording test summary and other data in a battery capacity discharge test

fold along this line—outside edges toward you

The battery is discharged into a resistance load such as a grid, carbon pile or water-barrel discharge unit. It is important that the discharge rate be watched carefully and maintained steady at the correct value. As the test progresses, the voltage across each cell should be read and recorded every hour up to the fourth hour and every half hour after that. The time of starting the test should be accurately noted. When the first cell of the battery shows a voltage of 1.7, the test discharge should be stopped and the precise time noted.

It is assumed that all cells will approach 1.75 volts simultaneously. However, if one cell reaches that point before the others, it should be shorted out of the battery circuit and the exact time of doing so recorded. Select one cell as a pilot. In addition, recording of the voltage of each cell for 6 hours will indicate which cell is most likely to reach 1.75 first.

At the end of the test, we have all of the figures necessary to calculate the condition of the battery, which will give an accurate idea of its life expectancy.

Figure 2 is a suggested form for recording the test data.

What we are trying to determine is how close to six hours the battery maintained a voltage of at least 1.75 across each cell. However, we must make corrections for the difference in specific gravity of the battery at the start of the test in a fully charged condition from 1.275.

We must also correct for the difference in temperature above or below 77 F. Note that the correction curves in Figs. 3 and 4, prepared by engineers of Gould-National Batteries, read directly in minutes, which are added in the case of specific gravity and either added or subtracted in the case of temperature.

How Correction Curves Work

Assume that the battery under test discharged at the 6-hour rate at a cell voltage about 1.75 per cell for 5 hours and 45 minutes, or 345 minutes The specific gravity of the battery at the start of the test was 1.260 and the temperature was 90 F.

Referring to Curve 1 (Fig. 3), we note that for a specific gravity of 1.260, 21 min should be added to the indicated elapsed time of the test. Referring to

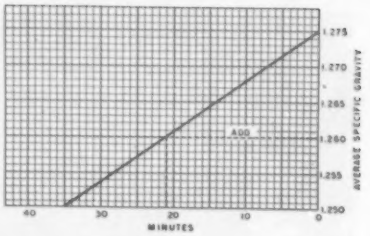


Fig. 3. Curve No. 1—specific gravity correction for battery, based on 6-hour rate of discharge

Curve 2 (Fig. 4), we note that for a temperature of 90 F, we should subtract 9 min.

Adding 21 min and subtracting 9 minutes we get a corrected test discharge time of 357 minutes. However, to obtain 100 per cent capacity, the battery should have discharged at the required rate for a full 360 minutes. Dividing 357 by 360 minutes, we get an efficiency of 99.16 per cent. This battery is obviously in good condition and need not be replaced in the near future.

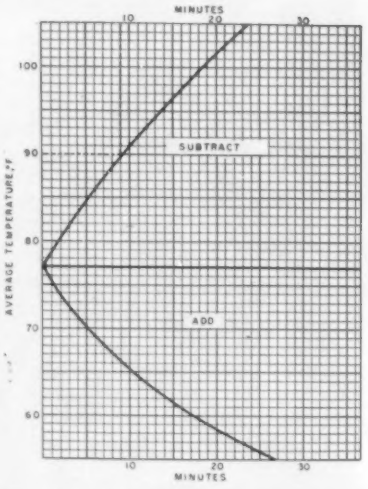
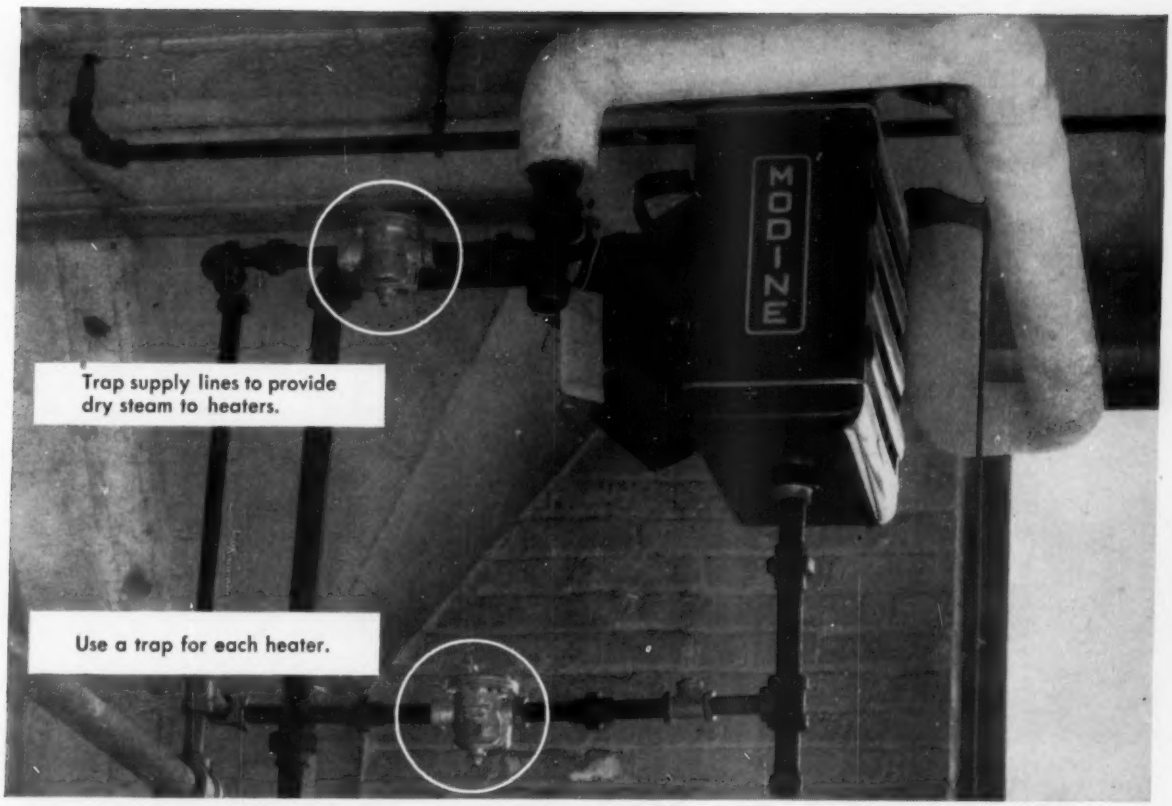
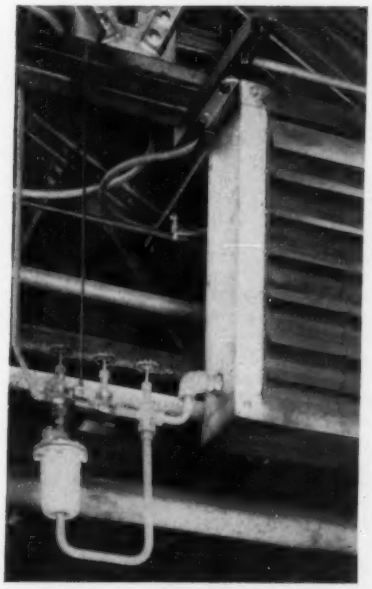


Fig. 4. Curve No. 2—temperature correction curve battery, based on 6-hour rate of discharge

cut along this line





Use a bypass above trap where heater must be kept in operation at all times. Note neat hookup possible with Armstrong vertical connection trap.

Tips on Trapping Unit Heaters for Full Output and Low Maintenance

• If unit heaters are clean and the steam supply and return lines are adequate, their performance will depend entirely upon the steam trapping. Here are some trapping pointers to insure plenty of heat when it is needed:

1. Trap supply lines to take care of condensate formed by radiation loss.

2. Use one trap for each heater. Two or more heaters drained by a single trap will fail to deliver maximum btu output.

3. Size traps properly. Many a unit heater is handicapped by a trap lacking adequate condensate and *air* handling capacity. The few dollars extra for larger traps insure fast heatup, full output and freedom from coil corrosion.

4. Install traps correctly. Put trap below and close to heater. Install a bypass around the trap if the heater must be kept in operation at all times. A shut-off valve in the discharge line facilitates trap inspection. Use of check valves and strainers is dependent upon piping conditions and the traps used.

5. Protect against PRV failure where freezing could occur. Sometimes heaters supplied with reduced pressure steam are installed where freezing could occur if traps failed to open. In this case select traps that will open at maximum steam supply pressure and still have adequate capacity at reduced pressure.

FREE ON REQUEST—COMPLETE INFORMATION on the above points, diagrams, selection data, tables and additional recommendations are contained in Armstrong Bulletin No. 2312. Also includes BTU output ratings for all models of 30 makes of unit heaters. Call your local Armstrong Factory Representative or write:

ARMSTRONG MACHINE WORKS
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ARMSTRONG STEAM TRAPS

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Bronze Globe Valves

14 DIFFERENT MODELS— ONE FOR YOUR SPECIFIC REQUIREMENTS

• R-P&C's complete valve line includes 14 different models of bronze globe valves, each in a complete range of sizes. Ranging in pressure classes from 125 to 300 lbs., they include flanged or screwed ends, union or screwed bonnets and a variety of seat and disc constructions. One of these 14 valves will solve your particular problem.

For example, **Fig. 427-DP** above was developed specifically for services where control or regulation of flow is required. The full-plug construction permits closer regulation—and the stainless steel seat and disc (500 Brinell) resist wire-drawing, give longer life. Rated for 300 lbs. Steam—1000 lbs. OWG.

FREE WALL CHART
"How to Protect Your Valves"
22" x 17" wall chart gives installation and operation pointers. Tells how to protect valves, prolong life. Write for your copy.

The **Fig. 1-A** valve, rated for 150 lbs., was developed for applications requiring tight shut-off and frequent operation. The special asbestos-composition disc seats tightly even if particles of foreign matter are trapped between seat and disc. The disc is easily renewed.

No matter what your requirements in bronze globe valves, R-P&C has the answer. And this holds true for angles, gates and check valves in iron and cast steel, also forged steel gates. See your R-P&C dealer today, or write for catalog.

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Extraction Heater

continued from page 79

present in the steam at that point.

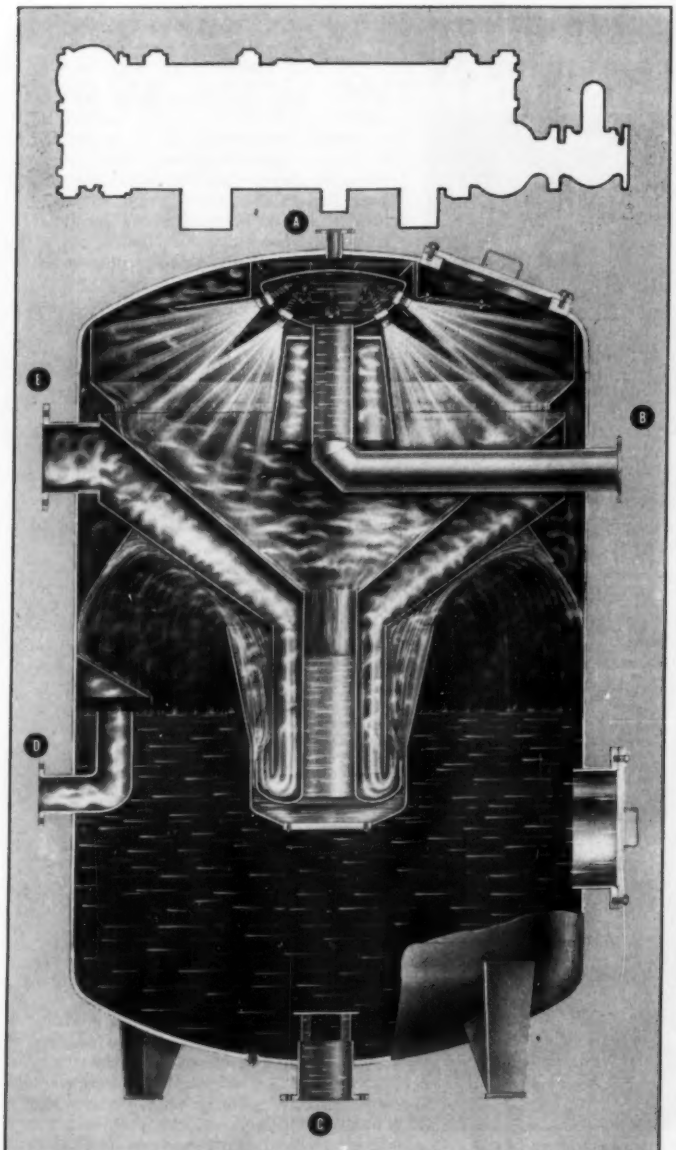
Superheated steam behaves as a gas and not as saturated vapor, consequently it is the practice of heater manufacturers in designing the so-called high heater to enclose by baffles or other arrangement a certain number of square feet of heater surface for the purpose of extracting the superheat from the steam on bringing it to a saturated condition where heat transfer takes place more effectively than at the balance of the surface of the heater.

The application of the de-superheating zone in the high heater results in a phenomena known as zero or negative terminal difference, that is, the temperature of the water leaving this heater for the boiler will be at a temperature higher than the saturation temperature in the heater corresponding to the pressure. A cooling zone for the purpose of reducing the temperature of the condensed steam in the extraction heater to within say approximately ten degrees of the temperature of the water entering the tubes from the next lower heater serves to reduce the flash loss, as heaters are generally cascaded drip-wise from one to another. The cooling zone, similar to that of the de-superheating zone is simply the walling off of a certain amount of heater surface to bring about this necessary temperature change.

Drain and Vent

For the vertical heater during the start-up and until extraction pressures rise to a point that will force the condensed steam through the now vertical cooling zone into the next heater, a drain at the bottom of the heater must be used. To avoid a further burden on the operating force of the station this change from the bottom drain to the regular flow of condensed extracted steam may be done automatically by the use of a type of pressure-actuated valve (see Fig 3) which will automatically bring about the change in valve conditions. It is absolutely necessary to maintain in the shell of the heater a certain amount of condensed steam to adequately cover the cooling zone of the heater. To do this automatically a pressure operated valve may be used for such drainage purposes as shown in Fig. 4.

The manufacturers of closed heaters today are giving more attention to adequate and properly located vents. It is true that a very limited amount of non-condensible gas comes over from the boiler with the steam today, but nevertheless there is a finite amount of such gas. To eliminate it vents must be provided and must be used and should be in continuous operation. These are usually cascaded from the high to the next lower heater, down the cycle to the condenser. A very convenient means of controlling this flow of a mixture



Full-contact deaerator needs no external vent condenser (white outline). The full-contact design effectively concentrates the vent-mixture inside the deaerator shell.

A Vent to atmosphere
B Water inlet
C Pump suction connection
D Overflow connection
E Steam inlet

WORTHINGTON

Now! Do away with deaerator maintenance

Here's a modern deaerator that eliminates most service problems because it has no vent condenser.

Virtually eliminates maintenance. Crammed up against the ceiling, vent condensers are difficult to inspect and clean. With a Worthington full-contact deaerator you eliminate this trouble and expense. For plants that normally operate around the clock, shutdown for deaerator maintenance is rarely necessary.

The carefully proportioned displacement flow path provided in the full-contact design concentrates the vent mixture by direct contact inside the deaerator shell. The vent condenser is no longer necessary.

Saves space. Headroom required by the deaerator may be cut by several feet—an important consideration in today's modern power plants where space is at a premium.

High efficiency. Like all Worthington deaerators, the full-contact unit is highly efficient at light as well as full load, as confirmed by numerous field tests.

Full-contact deaerators in various shell arrangements are available in capacities from 2,000 to 3,000,000 pounds per hour. Bulletin W-210-B32 has complete details. Incidentally, for the small power plant, Worthington builds a line of low-headroom deaerators that eliminate expensive elevated construction. For details, write to Section S66, Worthington Corporation, Steam Power Dept., Harrison, N. J. In Canada: Worthington (Canada) 1955, Ltd., Toronto, Ont. S-66

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With R/M's Big 7 Packing Types you can reduce downtime tremendously

You can actually set up a schedule of preventive rather than corrective maintenance with R/M's Big 7 Packing Types. Their custom-built construction will give you superlative performance, reducing downtime and maintenance costs. Only 3 or 4 types are normally required in most plants.

Designed for peak performance. For example, R/M Type 2 packings for valve stems and expansion joints take up to 1000°F. Made of high asbestos content yarn, they will not burn like packings with high organic content. Also, lubricants are "ground in"—stay in for life.

Your R/M distributor will be glad to show you how you can easily reduce downtime and costs, lower inventories, and simplify ordering by making the custom-built Big 7 line of packings standard in your plant. All R/M packings for maintenance are sold only through authorized R/M distributors.

Type 1, for pumps, valves; **Type 2,** for high temperature valve stems, expansion joints; **Type 3,** for high speed rotary air compressors; **Type 4,** for corrosives, acids, viscous materials; **Type 5,** "Teflon"* for chemicals; **Type 6,** gasket materials; **Type 7,** for hydraulic and pneumatic equipment.

*Du Pont trademark

R/M'S BIG 7 PACKING TYPES MEET 95% OF ALL PACKING NEEDS

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MECHANICAL PACKINGS AND GASKET MATERIALS

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Extraction Heater

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of both steam and gas is to use an orifice nipple which may be made out of monel metal with a hole drilled in it. These nipples may be in the higher pressure range approximately six in. long and in the lower pressure range four in. long. The size of the hole drilled in the body of the nipple is usually one eighth to one quarter of an inch and as a further control, a needle-type valve is provided. The burden of this expansion obviously takes place in the nipple and not in the valve.

The following comments, based on experience, deal with installations which have been in service for some period of time, or those installations which have recently gone into service and have been operated approximately a month to six weeks, and have been involved in various kinds of trouble.

Check Points

Carefully check and dismantle the several automatic non-return stage or extraction check valves to see that the disk swings freely on its shaft and travels freely to the extreme upper position so that the valve disk is out of the flowing stream of steam so that the pressure drop through the valve may be as low as possible. Carefully check the internal conditions in the valve body for construction debris, such as the usual bottle caps, welding rod, welding bead and anything that might prevent the disk of the valve from promptly seating in case of loss of load and seat tightly so that no back up steam can flow from some source into the turbine and cause serious overspeeding. Several cases have occurred.

Check carefully the piping connections between the governor control system and the valves. See that they are correctly connected and that after the turbine is on the governor the mechanism and oil cylinder will release the valve mechanism so that it may open fully when on the governor.

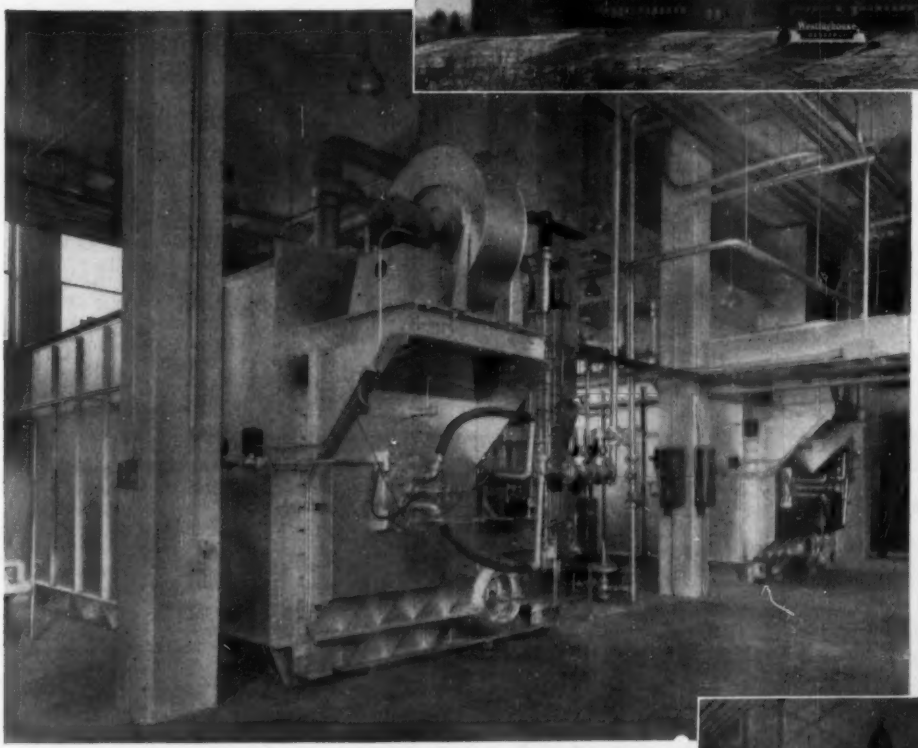
Carefully check and investigate each extraction heater tube sheet and clean out construction debris, also check to see that none of the tubes are plugged by such debris, so that the full capacity of the heating surface of the heater or heat exchanger may be fully available.

Carefully check the operation and the settings of all level control devices on the heaters so they maintain the water level in the heater at the point designated by the heater manufacturer. Clean and adjust these devices so that they function properly throughout the load cycle.

Investigate very carefully and check the operation and arrangement of the heater venting system so that all non-condensible gases may be out of the heater and it is full steam and not a partial mixture of gas and

TWO NEW KEELER TYPE D-K PACKAGE BOILERS SERVE NEW WESTINGHOUSE RESEARCH LAB

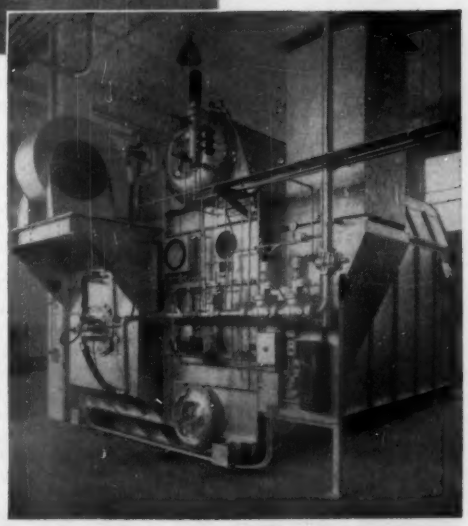
Westinghouse Research Laboratory
Churchill Boro, Pittsburgh, Pa.



KEELER

Type DK

Newest member of the Keeler line—a compact, low-cost package steam generator (oil or gas fired) for limited space requirements.



Westinghouse Electric Corporation has selected two Keeler D-K Package Steam Generators to supply their modern new research laboratory with low cost steam for process and heat requirements. Keeler Boilers of various types and sizes are serving Westinghouse plants throughout the country and their efficiency, economy and dependability led to the purchase of the two D-K units pictured here.

Each of the new Keeler Type D-K Boilers shown are capable of generating 20,000 lbs. of steam per hour. The complete "package" includes all burning equipment, controls, safety devices and accessories for gas fired operation.

The Type D-K is made in oil or gas fired units with capacities from 8,000 to 45,000 lbs. of steam per hour, standard design pressure of 200 psi and a maximum design pressure of 325 psi. The D-K is specifically designed for use in power plants which will not accommodate long boilers of other types.

It incorporates the proven efficiency and economy of Keeler Water Tube Steam Generators in a new, compact design—a comparatively wide and short boiler that's completely steel encased and insulated, ready for quick hook-up and operation. Write or phone for complete information on this compact, new Package Power Plant!

The Seal of Quality in Water Tube Boilers

Write For Bulletins

No. DK-1: Type DK Package Boilers
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No. M-2A: Type CPM Package Boilers
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FRAHM® FREQUENCY MONITOR

. . . for opening or closing an electrical contact when the frequency of the power line to which the monitor is connected reaches a preset limit. The monitor can be furnished for low or for high limit operation.

TYPICAL APPLICATIONS

. . . In power transmission systems as a low frequency alarm with manual reset to call for load shedding or other corrective action to bring system frequency back to normal.

. . . For generators as low and high frequency alarm and, under certain conditions, as simple "on-off" frequency controller which can keep frequency between preset low and high limit.

. . . For turbines and other machinery with parts rotating at high speed as overspeed alarm and limiter when used in conjunction with an electric tachometer generator.

Write for **PRICES** and **BULLETIN 33-06-PE**

Biddle Motor and Phase Rotation Tester *(Dual Purpose)*

With it you can . . .

- **Determine the direction of rotation of electric motors before they are connected to the line.**
- **Determine the phase rotation or sequence of energized power circuits.**

Here is a positive means for determining which motor leads must be connected to certain conductors of a supply system to insure that the motor will rotate in a prescribed direction when energized.

This device will permit the electrical contractor or industrial maintenance electrician to permanently connect and tape the terminals of the motor being installed, without having to first energize the motor by a temporary "hook-up" from a power source, if available, to determine its rotation.

Housed in a sturdy oak case 12¼" x 8¼" x 4¼" this compact unit weighs approximately 10 pounds and is supplied complete with 3 line and 3 motor leads which store in the compartments either side of the instrument panel.

For complete details write for **BULLETIN 80-PE.**

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- ELECTRICAL TESTING INSTRUMENTS
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Extraction Heater

continued from page 120

steam, thereby interfering with its operation and rate of heat transfer.

After checking the installation thoroughly for the ordinary mechanical difficulties of dirt, of venting, of water level control, and plugged tubes, then carefully check and familiarize yourself thoroughly with the fundamental heat cycle design or arrangement. This can best be done by constructing a single line diagram, or there may be one available in the design papers so that you may be fully informed as to what the expected performance is of all heaters, both closed and open, and other heat reclaiming devices such as exchangers.

After the cycle diagram is available, carefully check and familiarize yourself thoroughly with the manufacturers expected performance data, usually found in the heater or heat exchanger specification sheets.

When this is done, then the temperatures of water in and out of the heaters or exchangers should be checked by thermometers known to be accurate, also carefully check the temperature of the drip, drain or condensate leaving the heater to see how close the entering temperature to this heater conforms to the manufacturers' expected performance, or the design predicted performance.

For the older stations, unfortunately not too much attention was paid to this, but means of correcting it are readily at hand by the addition of an external drip cooler of the pipe and fin-tube type.

Pressure Drop

The conventional design assumption for pressure drop in steam extraction piping from the turbine flange to the heater has been five percent, but it must be borne in mind that the internal pressure drop in the turbine to the flange is approximately five per cent and the piping drop adds another five per cent. In some cases extraction heaters have been installed at some considerable distance from the turbine. If this pressure drop in the extraction piping exceeds five per cent then serious consideration should be given to moving the heater nearer to the turbine to reduce excessive pressure drops. The idea is to make the greatest possible use of all extracted steam and finally to deliver feedwater to the boiler at the highest possible temperature consistent with general cycle arrangements.

For the new installation on the drawing board and under discussion and consideration, most careful consideration should be given toward lower temperature terminal differences, lower temperature of drip going to the next lower heater to keep the flash losses to a minimum, the recovery of stray losses and low head heat such as the generator, the oil cooler and the fundamental rule: that all of these savings are cumulative.

YOU CONSERVE POWER INCREASE EFFICIENCY REDUCE MAINTENANCE

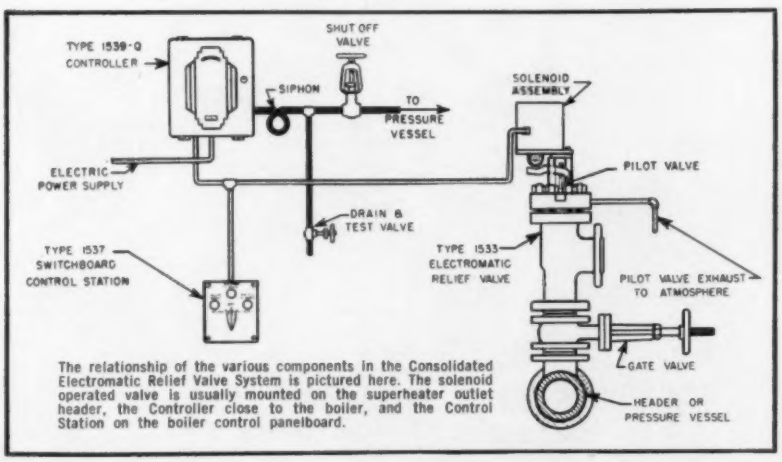
WITH THE CONSOLIDATED "ELECTROMATIC" RELIEF VALVE

The ideal auxiliary valve for steam generating plants with pressures to 2500 psi and temperatures to 1100° F., the Consolidated Electromatic Relief Valve relieves pressures precisely within close limits with "quick as a wink" cyclic action. It's an automatic, electrically actuated valve that can be accurately set for a differential of 1% or less between the opening and closing pressures.

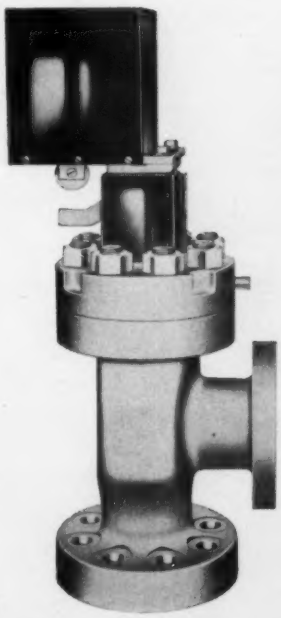
Operated by a solenoid actuated by a control station mounted in the panelboard, merely setting the switch provides automatic or manual service or cuts the valve out of operation. High superheat temperatures or other variables do not affect valve operation. A constant pressure output is maintained on the superheaters.

The Electromatic is also used to purge superheaters during start-up or as a superheater surge vent valve to reduce substantially the possibility of damage to equipment.

Wherever the Electromatic supplements spring-loaded safety valves, power is conserved, the efficiency of steam generating equipment is increased and maintenance is reduced. The Consolidated Electromatic Relief Valve is available in these sizes: 2½", 4", 10" and 14". Get complete specifications and operational details. Send for Bulletin 720.



The relationship of the various components in the Consolidated Electromatic Relief Valve System is pictured here. The solenoid operated valve is usually mounted on the superheater outlet header, the Controller close to the boiler, and the Control Station on the boiler control panelboard.



In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario.

CONSOLIDATED SAFETY VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONN.

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, CONSOLIDATED SAFETY VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Okla.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

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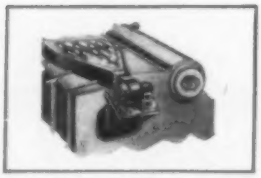
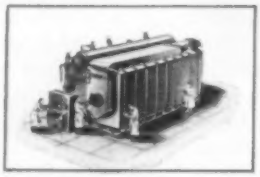


Rear mounted forced draft fan keeps firing front clear and provides proper flow of air to burner register preventing distortion of flame.

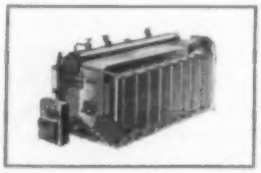
NEVER BEFORE SO MUCH IN A PACKAGE BOILER

Capacities to 50,000 lbs. per hour

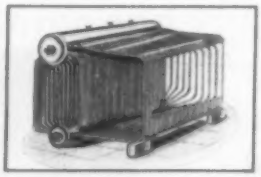
Designed to comply with or exceed Government Specification MIL-B-170958. Either left or righthand units can be supplied.



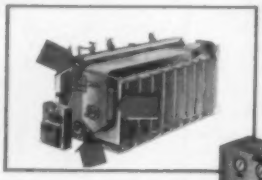
Completely plant assembled and factory fire tested with auxiliary equipment for capacity, efficiency and performance.



Rotary cup or steam assisted burners. Multiple burners where required. Burners for oil, gas, or both available on all units.



Tangent tube, waterwall furnace, all riser elements, discharge directly to steam drum. Drums extend both ends for maximum volume and releasing area.



Adequate inspection openings in casing. Refractory lined access door. Two manholes in each drum on sizes over 15,000 lbs. per hr.

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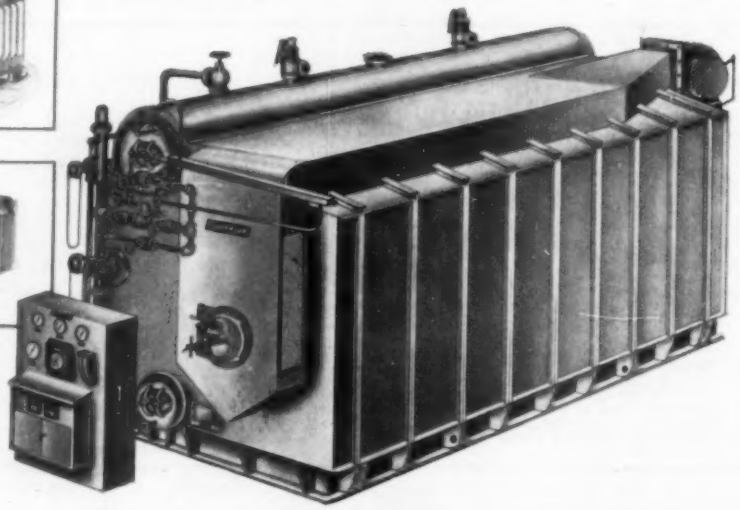

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COAL, ASH HANDLING

201 Tractor Shovel — The engineering, design and production stories of company's HD-11G tractor shovel are pictorially presented in 8-pp Catalog MS-460. Includes specifications and describes various features which mean easier servicing for less time-down and greater operator comfort. Allis-Chalmers Mfg. Co.

202 Spreader Stoker — Sixteen-pp Bulletin 800 describes manufacturer's Type C-C RotoStoker, a relatively small spreader stoker offering continuous cleaning and ash discharge advantages of larger units, without need of a basement for ash-removal. Explains this and other operational advantages of the stoker, which is adapted to modern steam boilers with output capacities to 75,000 lb of steam per hour. Detroit Stoker Co.

203 Why Liquid Diffusion — What liquid diffusion can do for power plants is explained in Form B, which tells how liquid diffusion compounds work and gives four practical applications. These include dust control in coal handling, fly-ash control, coal storage pile treatment and boiler cleaning. Johnson-March Corp.

204 Improved Crushers — Bulletin 12-C, 16-pp, describes company's line of crushers for reducing coal, coke, glass cullet, gypsum, lime, metal turning, sugar, sulphur and similar lump materials. Covers Knittel ring type crushers, two-stage double-roll crushers, single-roll crushers, and double-roll crushers. Photos, dimensional drawings and full specifications are included. Stephens-Adamson Mfg. Co.

FUEL BURNING EQUIPMENT

205 For Burning Refuse Fuel — This 8-pp bulletin describes refuse fuel burning equipment, including a pneumatic refuse fuel distributor which spreads refuse fuels such as bark, wood chips, and bagasse uniformly over the grate surface. Discusses construction features of various components. Riley Stoker Corp.

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206 Steam Atomizing Oil Burners — Sixteen-pp illustrated Bulletin 21 describes steam atomizing oil burners and auxiliary equipment for use with heavy oil or tar in boilers, stills, dryers and other furnaces where steam or compressed air is available for atomizing the oil. Includes information on furnace design and construction. National Airoil Burner Co., Inc.

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207 Automatic Burner — Bulletin 420 contains approximately 30 pp of engineering data on a new burner unit for gas, oil or combination firing and sized for capacities to 42,000 lb of steam per hour. Separate sections of this looseleaf manual are devoted to photos and discussion of special features of the burner, general specifications, parts list, wiring and piping diagrams, explanation of operating sequence, and performance data. Available to qualified power engineers, please state your job title when requesting this bulletin. Peabody Engineering Corp.

TUBING AND ACCESSORIES

208 Rotary Tube Cleaners — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads. Roto Div., Elliott Co.

209 Nickel Pipe and Tubes — Bulletin T-17 is a 28-pp technical bulletin on the fabrication and design of nickel and high nickel alloy pipe and tubing, illustrated throughout by drawings and photos. Presents tables on mechanical and physical properties, ASME code requirements, recommended welding procedures. The International Nickel Co., Inc.

210 Life Extension for Condenser Tubes — The 32-pp current edition of this booklet reports on research into the causes of corrosion and means of combating them, as well as the choice of condenser tube materials. Points out that Admiralty metal, long a standard for power plant condenser tubes, works satisfactorily in most installations, but other alloys may be necessary in some circumstances. Revere Copper and Brass, Inc.

211 Tube Cleaners — Catalog 76-A provides 48 pp of information on manufacturer's line of tube cleaners. Following equipment selection and operating hints, this practical catalog describes and pictures cutter heads and drill heads, brushes, and motors, giving sizes, application information. Thomas C. Wilson, Inc.

WATER CONDITIONING

212 Handbook on Demineralizing — Comprehensive 40-pp Bulletin 5800-B compares various methods of water treatment, indicating the comparison between demineralizers and evaporators. It discusses the characteristics of the various types of available cation and anion exchange materials and offers data on operating costs of demineralizing. It tells when to use 2-bed, 3-bed, 4-bed, mixed or monobed demineralizers. It also indicates when decarbonators or vacuum deaerators should be installed. Cochrane Corp.

213 Water Treatment—Bulletin 5000, 24 pp, explains the reasons for boiler water treatment and tells services offered by company in providing formulations for individual plant requirements. Covers pre-treatment, internal treatment, treatment application, blow-down adjustment, test control. Dearborn Chemical Co.

214 Water Conditioning Data Book — An excellent reference volume, Data Book 2478A contains 108 pp and presents a compilation of 78 chapters and tables. Subjects covered include hydraulics; impurities in water; chemical conversions; coagulant, acid and alkali dosages; chemicals used in water treatment; water treatment processes; boiler feed make-up

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requirements; alkalinity relationships; specific gravities; chemical reactions. Available to qualified power engineers, please state your job title when requesting this. The Permutit Co.

215 For Feedwater Analysis — Bulletin 148BP contains a technical discussion of manufacturer's analyzers for determination of dissolved oxygen and hydrogen in feedwater. Discusses both O and H units as to function, ranges, accuracy. Cambridge Instrument Co., Inc.

216 For Industrial Water Softening — Greensand, zeolite and resinous exchange water softeners are described in 8-pp Form S-105. Discusses features and applications of each of these basic types and illustrates some installations. Includes capacity data and general specifications. Also describes and pictures controls for water softeners, pressure filters and deionizers. Illinois Water Treatment Co.

217 pH and Chlorine Control — The 12th edition of company's handbook "Modern pH and Chlorine Control," 100-pp, incorporating theory and practice of colorimetric analysis, serves as a reference for quantitative determination of pH, chlorine, phosphate, nitrite, sulfate, hardness and other tests. Slide comparators and complete test kits are illustrated. In addition to standard pH determinations, methods are outlined for quantitative analyses of phosphate, calcium, magnesium, silica nitrate hardness in feedwater. Available to qualified power engineers. W. A. Taylor Co.

218 Feedwater Treatment — Process Bulletin B1, "Treatment of Boiler Feedwater by Direct, or Internal Method," discusses advantages of direct treatment, as a complete treating program or as a supplement to external systems. Explains why direct treatment is convenient, economical and complete, and points out how it improves steam quality and reduces boiler maintenance costs and downtime. National Aluminate Corp.

219 Carbon Dioxide Measurement — Technical Paper 133, 16-pp, discusses determination of CO_2 in water by conductivity measurements. Describes a new method developed for the determination of carbon dioxide which is applicable to analysis of waterside deposits, treatment chemicals and organic carbon in water. W. H. & L. D. Betz.

VALVES, TRAPS, PIPING AND ACCESSORIES

220 Check Valves — Twenty-pp Catalog 30 presents company's line of tilting-disc check valves made in iron, bronze and steel for working pressures to 3000 psi. Explains operating principles of tilting disc construction, discusses closing without slam, reduced loss of head, other advantages. Includes construction details, sizes. The Chapman Valve Mfg. Co.

221 Lubricated Plug Valves — Catalog PV-24, 36-pp, shows in detail a line of iron and steel lubricated plug valves. Many illustrations of the single, screwed and bolted gland type valves are shown, including photos, sectional and detailed drawings. Also included is physical data on dimensions. The Wm. Powell Co.

222 General Purpose Valves — Supplement No. 1 to Catalog F-9, 32-pp, offers complete information on company's series of general purpose drop forged steel

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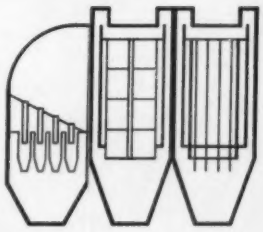

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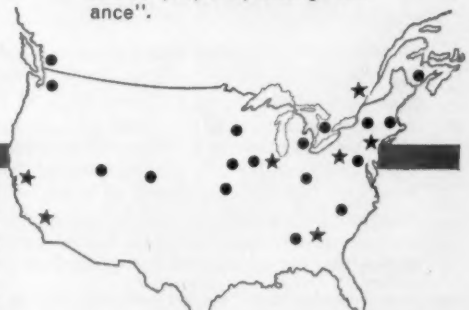

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valves, gate, globe and angle types, sizes ¼ through 2 in. Includes descriptions of each type along with drawings showing component parts. Dimensions and other specifications are tabulated, and a pressure-temperature ratings table is included. Henry Vogt Machine Co.

223 Valve Charts — Now available to power engineers are three well-organized wall charts on valve types, selection and protection. "How to know valves" covers four main types of valves from the standpoints of their appearance, inside construction, service intended, operation and use. "How to select valves" discusses five major factors involved in the choice of a valve — fluid, temperature, pressure, size and function. "How to protect valves" — written in "do and don't" style covers 11 important points in valve installation, operation and maintenance. R-P & C Valve Div., American Chain & Cable Co., Inc.

224 To Get at Those Valves — This little folder describes a sprocket rim with chain guide. The rim adjusts to fit all valve wheels. Babbitt Steam Specialty Co.

225 Regulating Valves — Bulletin 5305 describes double seated diaphragm regulating valves for use with control instruments, outlinging special features of the valves, particularly the "flow line" contoured-body engineered for high capacity at low pressure drop. Leslie Co.

226 Pump Valves — Key features of company's line of pump valves are outlined in 6-pp Bulletin V-112. Includes cutaway view showing design features, standard materials table, and a table of standard pump valve sizes. Sims Pump Valve Co., Inc.

227 Choosing the Right Valve — Presenting valve selection as a matter of matching the valve's service characteristics with service requirements of the job, this practical 20-pp booklet explains and illustrates basic design features of gate, globe and check valves. It tells, in non-technical language, how each of these valve types works, and where it is suited for use. Disc, stem connection, bonnet and bonnet-joint characteristics are discussed and illustrated. Crane Co.

228 Boiler Blow-Off Valves — Bulletin E-125, 24 pp, describes and illustrates the design and construction of company's quick-operating valves, angle valves, Y valves and duplex units specifically designed for boiler blow-off service. Includes dimensions. Everlasting Valve Co.

229 Steel Gate Valves — Four types of Hancock general purpose steel gate valves for process and power piping systems are described in illustrated Bulletin 202 C, 12 pp. Material specifications, dimensions given, also service pressure ratings. Manning, Maxwell & Moore, Inc.

230 Steam Trap Selector — Twelve-pp Bulletin T-9 is designed specifically to aid in selection and application of steam traps on chemical processing equipment. Features a foldout piping diagram for 22 pieces of typical processing equipment — each showing recommended steam trap and piping arrangements. Also contains selector tables. Yarnall-Waring Co.

231 Steam Trap Book — Catalog J, 44 pp, serves as a manual of trapping practice. Includes a catalog section giving physical data and prices on cast semi-steel and forged steel inverted bucket steam traps, compound steam traps and ball

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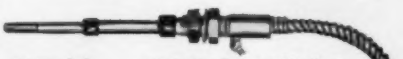
Accuracy . . . High Load Capacity . . . Adaptability . . . Freedom from Trouble . . . Long Life . . . Flexibility . . . these are some of the qualities of **ACCO TRU-LAY PUSH-PULL FLEXIBLE CONTROLS** that have made it possible to improve the operation of literally hundreds of mechanical products (list on request). Full description of this versatile REMOTE CONTROL is given in our **DATA FILE** available for your further study.

ACCURACY is inherent in the basic design, and in the standards of quality and precise dimension that control the manufacture of TRU-LAY PUSH-PULL CONTROLS. These are precision products, not gadgets.

VERSATILITY of this fine remote control can best be illustrated by citing some of the jobs it handles well . . . **HOT** jobs on jets and industrial furnaces . . . **COLD** jobs down to —70° F. . . . **WET** jobs (the conduit can be completely immersed) . . . **DIRTY** jobs . . . **ABRASIVE** jobs . . . **CORROSIVE** jobs . . . **HEAVY, TOUGH** jobs up to 1,000 lbs input . . . **LIGHT DUTY** jobs . . . **REMOTE** jobs 150 feet or more from the control point . . . these units are frequently and successfully used in conjunction with electric, hydraulic and air controls . . . are thoroughly effective under almost any operating condition.

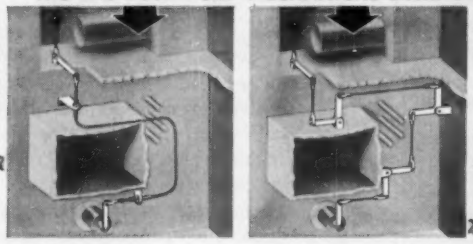


"SOLID as a rod but FLEXIBLE as a wire rope" aptly describes TRU-LAY PUSH-PULL CONTROLS. This *flexibility* provides positive, remote action whether anchorages are fixed or movable . . . it damps out noise and vibration—protects delicate instruments . . . it permits ease of handling and shipping even when assemblies are 100 or 150 feet long . . . it avoids the risk of damage always present with solid tubular controls that must be preformed to position . . . and flexibility greatly simplifies installation of controls by reducing the number of working parts and by making it possible to snake around obstructions. . .

Advantages of Tru-Lay Push-Pull flexibility and simplicity are pictured below

TRU-LAY PUSH-PULL MECHANICAL LINKAGES

Simple
One Moving Part
Life-Time Service
Life-Time Accuracy
Low over-all Cost
Noiseless



Complex
Many Parts
Many Points of Wear
Increasing Back-Lash
Loss of Accuracy
Vibration
Rattles

ADAPTABILITY to all sorts of mechanical situations explains, in large measure, the wide-spread application of TRU-LAY PUSH-PULLS. Standard anchorages, fittings and heads have been designed that meet requirements on approximately 80% of the installations. Simple modifications of these standards, or minor changes in your own design, cover almost every special situation. Our engineers have the know-how on such matters.

FREEDOM FROM TROUBLE and **LONG LIFE** are assured even under exceptionally adverse operating conditions because of such things as . . . full protection of the flexible, inner, working member by the tough flexible conduit . . . lubrication of the inner, working member *for life* during assembly . . . seals that keep moisture, dust and other foreign matter out of the unit . . . cold swaging of fittings that makes them integral parts of the control unit. (Full construction details in our **DATA FILE**). We have never heard of a TRU-LAY FLEXIBLE PUSH-PULL CONTROL wearing out in normal service.

Whether your interest is in a single application of this versatile PUSH-PULL CONTROL, or in its inclusion as a component of the product you manufacture, the six booklets and bulletins in this **DATA FILE** will answer your further questions, and will also provide you with the means of defining to us the application you may be interested in.

The six bulletins and booklets in the DATA FILE will answer all your further questions. Write for your copy.

ACCO

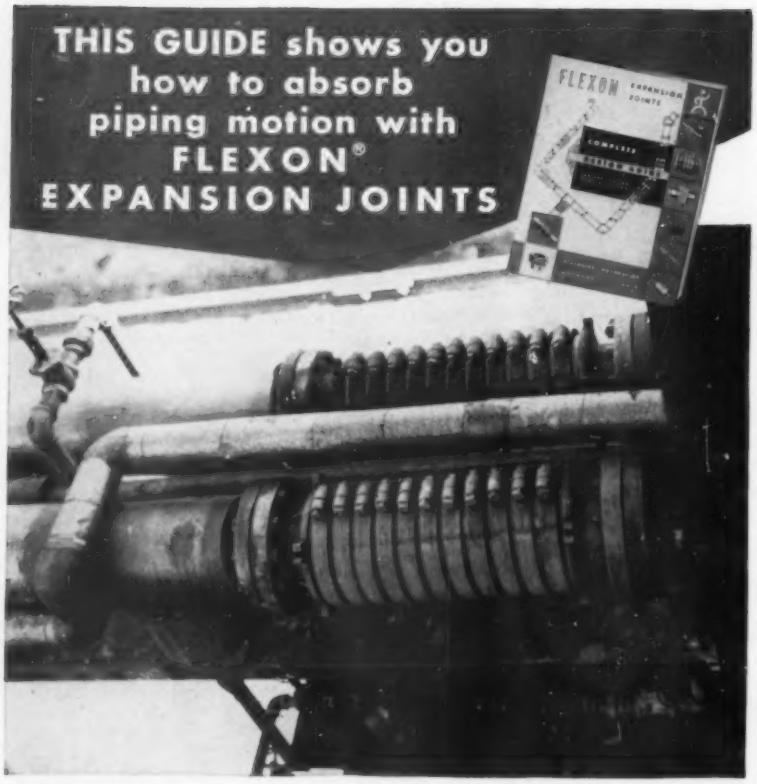
TRADE MARK

AUTOMOTIVE and AIRCRAFT DIVISION
AMERICAN CHAIN & CABLE

Push-Pull DATA FILE

601-M Stephenson Bldg., Detroit 2
2216-M South Garfield Ave., Los Angeles 22 • 929-M Connecticut Ave., Bridgeport 2, Conn.

For more data circle 564 on Post Card



FLEXON® EXPANSION JOINTS

FREE FLEXING TYPE — *Available in sizes from 3" through 48", I.D. in copper or stainless steel. Suitable for pressures from vacuum to 50 psi and temperatures from sub-zero to 850° F.*

CONTROLLED FLEXING TYPE—*Available in sizes from 3" through 48", I.D. with copper or stainless steel pressure carrier and cast iron control rings. Suitable for vacuum to high pressure ranges and temperatures from sub-zero to 850° F.*

SPECIAL TYPES—*A variety of assemblies are available for special requirements including special very high pressure units for pressures to 5500 psi. For recommendations send an outline of your requirements.*

Here is the authoritative handbook on piping design and layout. Gathered together in this one easy-to-use booklet is a wealth of comprehensive, up-to-date information on modern methods of absorbing pipe motions. Included are thorough discussions of types of motion, design considerations and physical characteristics of expansion joints, anchoring and guiding, typical piping layouts, thermal expansion tables, safety factors and many other important elements vital in piping layout.

Complete specifications are given on all types of Flexon Expansion Joints. These units contain no packing, therefore require no maintenance. Wherever motion or misalignment is present in pipelines you can install Flexon Expansion Joints and forget them.

Much of this data is available only in the Flexon Expansion Joint Design Guide. Copies are available without charge. Write for yours today.

FLEXON® QUALITY
proved in service and backed by over 54 years' manufacturing experience

EJ-24

Flexonics *Corporation*
EXPANSION JOINT DIVISION
1374 S. THIRD AVENUE, MAYWOOD, ILLINOIS
FORMERLY CHICAGO METAL HOSE CORPORATION
Manufacturers of flexible metal hose and conduit, expansion joints, metallic bellows and assemblies of these components.
In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

For more data circle 565 on Post Card

float air and air relief traps; a handbook section explaining how to calculate condensate loads and select traps for all classes of equipment; a maintenance section explaining trap installation, as well as trouble-shooting and repair. Armstrong Machine Works.

232 Expansion Joints — Rubber expansion joints for relieving strains and stresses in piping, absorbing vibration, and eliminating noise are the subject of 8-pp Form AD-137. General advantages of rubber expansion joints are presented, and spool-type, U-type and rectangular-type joints are described as to construction and intended services. Also provided is catalog sheet on all-Teflon joints and Teflon-lined rubber joints. The Garlock Packing Co.

PUMPS, COMPRESSORS

233 Controlled Volume Pumps — Bulletin 953, 24-pp, describes and illustrates use of controlled volume pumps in industrial water treating systems. Construction and operation features are described, capacity-pressure ranges and speed and stroke length adjustments are charted. Typical chemical feed and water treating systems are presented through text and diagrams; and an analysis of boiler water treating systems, cooling water treating problems, and systems for waste and sanitary water treatment included. Milton Roy Co.

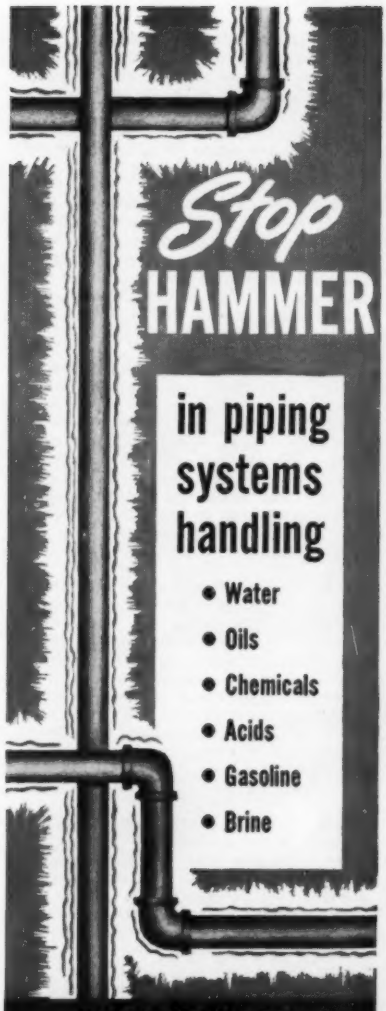
234 Boiler Feed Pump — Bulletin 08B7899, 16-pp, describes design features and principal advantages of company's barrel type boiler feed pumps. Shows why balanced thrust design gives radial and axial balance for greatest reliability and for smooth operation and longer pump life. Allis-Chalmers Mfg Co.

235 Steam Pump Care — Bulletin G-2280, "How to Install and Take Care of Steam Pumps," is a 24-pp booklet containing a step-by-step series of 88 illustrations showing how to increase the service life of all types of steam pumps. It offers 28 tips on proper installation of the pumps, 54 tips on care techniques. Section on installation provides information on suction, packing the pump, starting it, and trouble shooting. Section on maintenance deals with such subjects as steam valves, liquid piston and rod, piston packing, liners, gaskets and many others. Worthington Corp.

236 For Abusive Pumping Jobs — Catalog 4906, 36 pp, covers centrifugal pumps for wide industrial use and especially adapted to handling ashes, abrasive mixtures, slurries, hot and corrosive liquids. It describes several basic types: a horizontal shaft, single-stage side suction pump; a horizontal shaft, single-stage, rear-entrance automatic priming pump; vertical shaft pumps with standard, overhead and quill bearings for wet pit applications. Nagle Pumps.

BOILERS, GENERATORS

237 Packaged Boilers — This 16-pp illustrated catalog describes manufacturer's new Type VP package boiler. Following a section of background information is an outline of the principal design features of these boilers, which are shop assembled and provide steam capacities from 4000 to 40,000 lb per hour. Space requirements are shown in a table along with typical specifications. Describes control system. Combustion Engineering, Inc.



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FLANGED
Silent
CHECK VALVES

Providing dependable protection against damage from "surge pressures," these *Silent* Check Valves may be installed in horizontal, vertical and angular positions.

Write for Bulletins:

No. 654 on the Valves

No. 851 on Cause, Effect and Control of Water Hammer

THE WILLIAMS GAUGE CO., INC.
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2 Gateway Center Pittsburgh 22, Pa.
Our 70th Anniversary • 1886-1956

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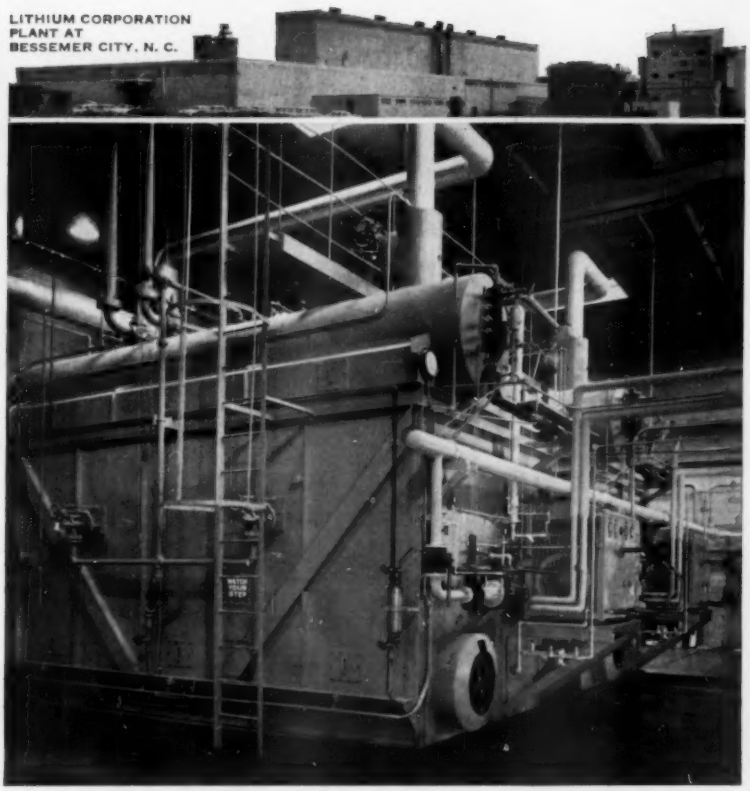

Industry's blistering pace demands...

ALL-OUT BOILER PERFORMANCE LIKE LITHIUM CORP. IS GETTING

Lithium, the "Horatio Alger" metal, is making an impact on every segment of industry... and Lithium Corp. of America's plant at Bessemer City, N.C. is meeting the mushrooming demand by peak load refining. This processing requires high pressure steam for vacuum jet equipment, a load of 60,000 lbs. per hr. at 140 psi. on the two Bros Packaged Boilers.

This peak load boiler performance is important, of course. Another big point in the Lithium plant boiler room is nominal maintenance; water tube inspection of these Bros boilers after 15 months of near-capacity operation showed *no scale formation.*

That's the kind of performance that makes a real hit with boiler engineers; yet Bros-engineered flexibility and economy pay off in the front office, too. Here's why:

Complete factory-assembled units. Bros Packaged Boilers are self-contained units, easy to transport and easily installed at low cost. They go on-the-line with simple service connections... no time or money wasted on slow, costly erections at the plant. These boilers quickly respond to varying loads; they supply steam requirements often expected only of larger, more expensive boiler equipment.

Capacities range from 4,000 lbs. steam per hour and up. Whatever your steam needs, Bros has the precise Packaged Boiler for the job. These units burn oil, gas, or both. Equipped with fully automatic, semi-automatic or manual controls.

WRITE TODAY for your free copy of the Bros Packaged Boiler brochure.

BROS

WM. BROS BOILER & MFG. CO.
POWER DIVISION
1057 Tenth Ave. S. E.
Minneapolis 14, Minnesota

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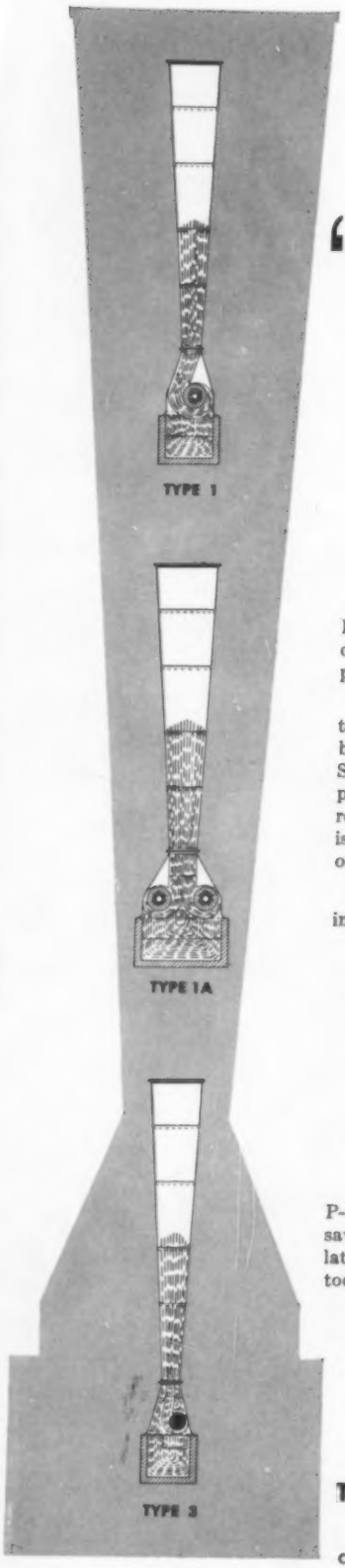

THE

"compleat"

STACK

INTEGRATED FAN, BREECHING AND STACK SELF SUPPORTING

P-D's single responsibility for draft production greatly simplifies your engineering problems.

P-D Fan Stacks are a completely integrated apparatus, consisting of I-D fan, breeching, and stack in a single unit. Straight through breeching assures high, predeterminable efficiency. Structural steel requirements are reduced and installation is simplified. Stack may be mounted directly on boiler steel where desirable.

Three basic types provide a wide latitude in application:

TYPE 1 — Single I-D fan handles total gas.

TYPE 1A — Twin I-D fan for widely varying loads . . . as a standby fan . . . or for handling two boilers with a single stack.

TYPE 3 — A small fan ejector in throat of stack handles portion of gas only. Patented tuyere controls ejector nozzle for load variation.

P-D Fan Stacks will give you substantial savings in original investment and installation costs. Write our Project Engineers today. Ask for Bulletin 1-PDC-1.

pd

Project Engineers

THE THERMIX CORPORATION

GREENWICH, CONN.

(Offices in 38 Principal Cities)

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Designers and Manufacturers

PRAT-DANIEL CORPORATION

SOUTH NORWALK, CONN.

POWER DIVISION: Tubular Dust Collectors, Forced Draft Fans, Air Preheaters, Induced Draft Fans, Fan Stacks

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238 Compact Generator — This bulletin describes a packaged water tube generator, company's Type DK, available in units for 8400 to 45,000 lb of steam per hour. Gives features, size and capacity data on these boilers which are designed to require less space than many water tube units. E. Keeler Co.

239 Steam Generators — Illustrated Bulletin SB43, 20 pp, describes company's VL factory assembled generators combining 2-drum water-type boiler, integral water cooled furnace, brick work, insulation and steel casing. A large cutaway illustration shows design details, and gas travel. Erie City Iron Works.

240 Improved Steam Generator — Bulletin 2000, 28 pp, explains advance design features that distinguish this manufacturer's generator from other unit steam generators. Describes and illustrates engineering differences of component features. Also shows how these components are constructed, assembled and tested. Another section gives data, and dimensions for the units which range from 20 to 6000 hp. Preferred Utilities Mfg. Corp.

241 Steam Generators — Bulletin 55-1, 22-pp, describes company's products and services, including not only steam generators but also custom metal fabrication. There are many photos of boilers in various stages of assembly. Engineering drawings of boilers producing up to 500,000 lb of steam per hr on standard fuels are included, as well as illustrations of units for waste heat application and those designed to utilize refuse for fuels — wood chips, coffee grounds. The Wickes Boiler Co.

242 Standard Boilers — Eight-pp Bulletin WT-8 describes company's "S" series of boilers with capacities ranging from 10,800 to 50,000 lb. Lists data and specifications on each of the models and sizes, and discusses general design features and special "S" type construction features. Wm. Bros Boiler & Mfg. Co.

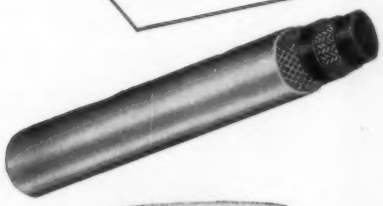
243 Water Tube Boilers — This 12-pp catalog describes packaged water tube boilers, capacities to from 8000 to 50,000 lb per hour. Interesting as well as informative, this booklet uses color and illustrations to amplify text. Gives complete data and dimensions for boilers designed for firing oil or gas or both. Superior Combustion Industries, Inc.

244 Packaged Generators — Bulletin MH 3-54, 14-pp, gives detailed coverage to company's Type MH packaged water tube steam generators which are furnished for oil or gas firing or both, with automatic, semi-automatic, or manual controls. Included are: cutaway illustrations, installation photos, tube arrangement layouts, construction details, auxiliary equipment, dimensions. Union Iron Works.

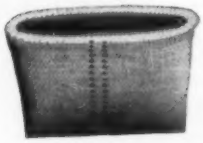
245 Automatic Boilers — Bulletin BE-4 describes operation and advantages of Continental automatic boiler's spinning gas technique — a method of obtaining maximum heat transfer with a simplified design. Shows cutaway view of boiler construction; illustrates hinged doors and method of injecting air through static, turbine-like vanes into burner. Boiler Engineering & Supply Co., Inc.

246 Shop-Assembled Boiler — Sixteen-pp Bulletin G-76 completely describes and illustrates company's Type FM water-tube integral-furnace boiler, made in standard sizes from 2900 to

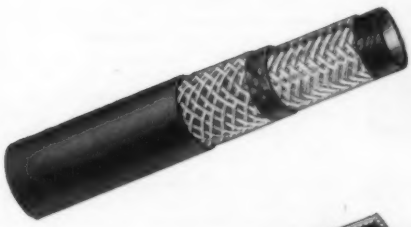
For long, trouble-free service . . . use Quaker hose



AIR Extra lightweight, highly flexible hose for heavy duty work. Resists weather damage and abrasion. Non-porous tube of oil resistant rubber compound. Rugged Neoprene cover. Ideal for almost any hose installation.



FIRE Resilient, flat-folding hose saves space and gives long service in interior fire protection. Highly flexible and resistant to cracking. Leak-proof tube bonded to strong single jacket cover. Recommended for institutions, offices, ships, etc.



STEAM Many times stronger than wrapped fabric hose for general steam-handling jobs. Also lighter, more flexible and kinkproof for easier handling. Steel wire and glass reinforcing insures extra safety. Resists high pressures up to 388° F.

WELDING No twisted, tangled lines. Two lines are securely bonded together to form a single, safe hose unit. Kink-free and resistant to welding gases. Stands up to lots of dragging across rough surfaces. Especially effective on portable welding dollies.

WATER For long wear and outstanding value, this easy-to-handle hose has what you need. Reinforced with multiple plies of high tensile yarn, it takes higher than usual working pressures. Cover stands up to weather extremes without cracking or peeling.

Save time and money. Call your Quaker-Quaker Pioneer distributor first, *when you need hose or other industrial rubber products. You'll find him prompt, dependable.*

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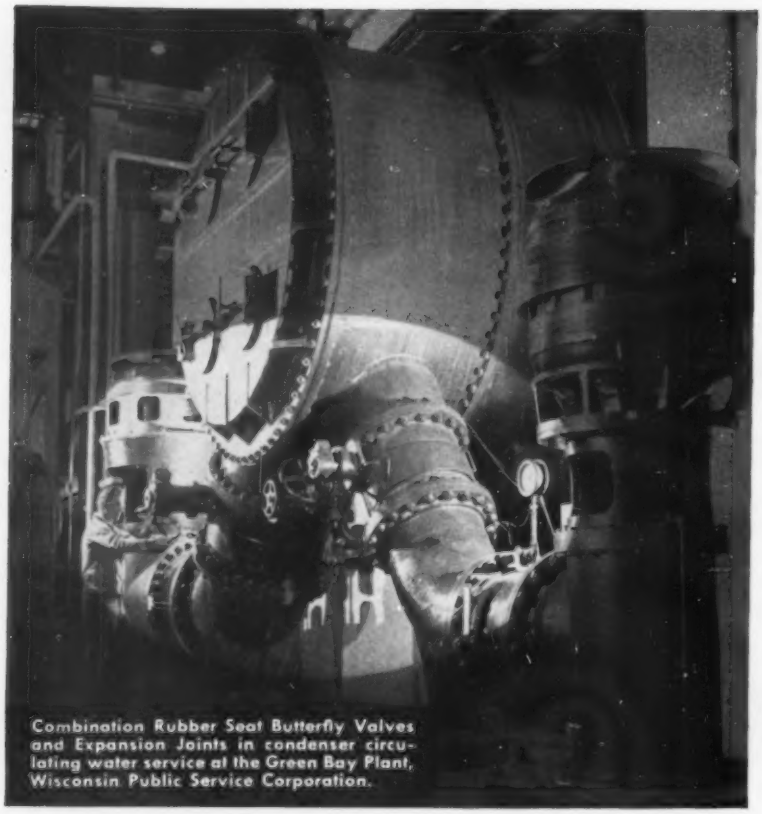


Combination Rubber Seat Butterfly Valves and Expansion Joints in condenser circulating water service at the Green Bay Plant, Wisconsin Public Service Corporation.

GREEN BAY...Combines Butterfly Valves with expansion joints for new economy

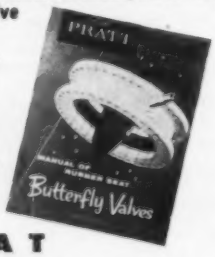
Drop-tight shutoff, plus provision for pipeline expansion and ease of assembly are provided here in one compact Pratt unit. By combining the Butterfly Valve with the expansion joint, space requirements are minimized and maintenance (and initial cost) of one set of flanges and bolts is eliminated. This is a typical Henry Pratt engineering job—the mechanisms are the simplest available . . . for economy and minimum maintenance, and they are carefully designed and built for peak efficiency and operating ease.

Henry Pratt pioneered the use of Rubber Seat Butterfly Valves in power plants. Combined with permanently drop-tight shutoff, the inherent simplicity and compactness of this valve permitted a new concept of large-diameter valving by power plant engineers.

Pratt Rubber Seat Butterfly Valves grew with the Power Industry for thirty years, and today are being installed in modern, nuclear power plants. For valve design—with **Imagination**—see Henry Pratt.

NEW! Latest, most accurate pressure drop and flow data, conversion tables, discussion of butterfly valve theory and application plus other technical information.

Write for Manual B-2G.



HENRY PRATT

RUBBER SEAT

Butterfly Valves

Henry Pratt Company, 2222 S. Halsted St., Chicago 8, Ill. Representatives in principal cities

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28,000 lb of steam per hr, pressure to 250 psi. The Babcock & Wilcox Co.

247 Packaged Generators — This 16-pp catalog covers a new series of packaged steam generators in sizes from 10,000 to 46,000 lb of steam per hour. Gives capacities, dimensions, construction features. Instrumentation is discussed. Illustrations include sectional drawings and installation photos. Booklet also provides a selection chart covering firing equipment and controls. Foster Wheeler Corp.

MECHANICAL POWER TRANSMISSION

248 V-S Drive Selection Tips — Bulletin 20P50, 44 pp, carries handy multi-color tables for quick and easy selection of variable speed Texrope drives. In addition to providing these tables for A, B, C and D section variable speed drives, booklet includes information on design features, drive principles, horsepower rating tables for A, B, C, D, and E section belts, a speed range table showing variation in rpm when using two Vari-Pitch sheaves in combination. Allis-Chalmers Mfg. Co.

249 Fluid Drives — Bulletins 9419 and 9519 are an illustrated catalog and selection guide on company's new Type VS Class 2 Gyrol fluid drives. Catalog discusses advantages and applications of the drives, covering speed control, power savings, simplified installation, etc. A sectional view shows construction and principle of operation. Dimensions for six sizes of drives are provided. Selection guide consists of tables indicating proper drive to use. American Blower Corp.

250 Speed Reducers — Design and operation advantages of company's line of Torque-Arm speed reducers are outlined in 28-pp Bulletin A-637. Includes selection tables for double and single reduction units, bore dimensions and bushings, data on overload releases, flange mounted speed reducers, and recommended V-belt drives. Dodge Mfg. Corp.

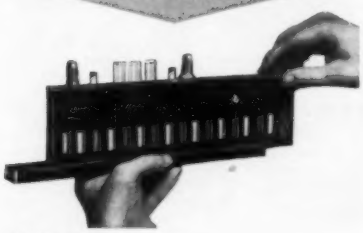
REFRACTORIES, INSULATIONS

251 Refractory Concrete — Basic information on recommended practice for mixing and placing refractory concrete, used in the metal, power, ceramic, and petroleum refining industry as a material to withstand service temp to 2600 F or more, is presented in this 16-pp manual. Sections are devoted to special properties of refractory concrete, aggregates, refractory insulating concrete, and structural design. Universal Atlas Cement Co.

When ordering catalogs, allow time for us to relay your requests to the manufacturers—and for them to mail out copies. Remember, manufacturers are often swamped with catalog requests.

252 Insulations, Refractories — This 20-pp catalog features thermal insulations and refractories for general industrial applications. Organized for quick reference, catalog provides information on composition, physical and thermal properties and sizes of the various products. Lists chief advantages, covers materials

ACCURATE pH, PHOSPHATE CONTROL with TAYLOR COMPARATORS REDUCES WASTE



Help determine EXACT amounts of chemicals needed for adjustments

By making accurate colorimetric tests of pH and phosphate content with Taylor Comparators, you can be sure of determining the exact amounts of chemicals needed to control scaling, corrosion and priming in boilers. Tests can be made in minutes—no experience is needed. Just fill test tubes with sample, add reagent to center tube and move color slide across until colors match. Even complete water analysis is only a little more detailed with the Taylor Water Analyzer.

Water hardness may be determined with the ease and accuracy of an alkalinity titration with the Taylor Total Hardness Set.

COLOR STANDARDS GUARANTEED

Taylor liquid color standards carry an unlimited guarantee against fading. There's no chance of mechanical inaccuracy. Each complete set of standards is mounted in a lightweight, plastic slide, eliminating the need for handling fragile, single standards.

SEE YOUR DEALER for Taylor sets, or write direct for FREE HANDBOOK "Modern pH & Chlorine Control." Gives theory and application of pH control, and illustrates and describes complete Taylor line.

W. A. TAYLOR AND CO.
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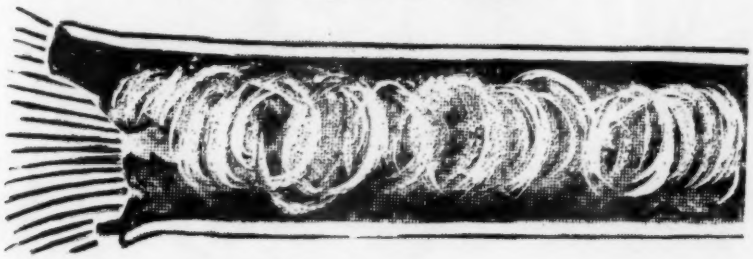
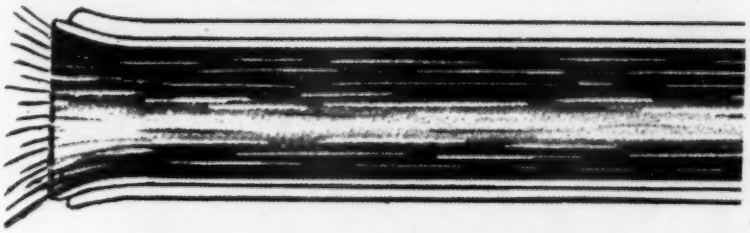
For this damaged tube . . .



THIS CURE

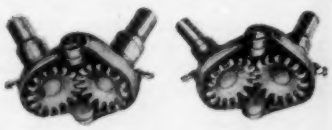


CONSECO FLOWRITES

INSURANCE AGAINST TUBE TROUBLE

Millions of times, in 25 years of service, under all conditions, FLOWRITES have proved they prevent tube end erosion. Conseco Flowrites are short molded nylon or metal tubes, inserted in the entrance end of condenser tubes. They are made of molded nylon or same metal as the tube itself. Eliminate gas and air pockets; prevent tube plugging; assure uninterrupted increased flow of water. Flowrites cost about 90% less than retubing; also prevent loss of revenue during plant shutdown. Flowrites are easy to install and repair, and are GUARANTEED. Write for special descriptive BULLETIN with M.I.T. Laboratory Report.

CONSECO UNIVERSAL GEAR BEVEL JOINTS



Solve shaft line-up problems; save on installation costs; reduce operating accidents. Positive transmission of torsion regardless of shaft angle, from 0° to 135° on vertical center line, or from 0° to 360° on horizontal center line. Capacity 1580 to 4938 inch pounds at 49 rpm. Five standard sizes for shaft diameters of ½", ¾", 1", 1¼", and 1½". Special shaft lengths to order.

Other specialties include: *coils for feed water heaters and evaporators, Conco cleaning guns and plugs, condenser ferrules, detectaleak tube testers, fibre plugs, metallic and fibre packing for condensers, Wizard condenser injectors, etc.*

• WRITE US FOR SPECIAL BULLETINS •

CONSECO SERVICE

Conseco Service for repair or maintenance of any type or make of tubular equipment is at your service any day, any hour, Sundays, holidays anywhere in the country. Just wire or 'phone our Service Department.

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CONDENSER SERVICE & ENGINEERING CO., INC. CONSECO

Designers and Builders of Equipment for Power, Refining, Chemical and Marine Industries

158 OBSERVER HIGHWAY
HOBOKEN, N. J.

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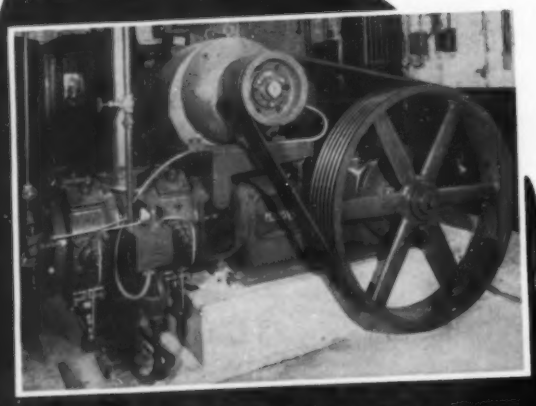

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for efficient control of temperatures from —400 F to 3000 F. Johns-Manville.

253 Refractory Notes — Included in Vol. XV of this company's Thermogram is an illustrated article on a method for decreasing hot topping costs in steel mills with minimum capital expenditure. Another story tells how bonded brick assemblies cut installation time in a coke plant. Refractory & Insulation Corp.

ELECTRICAL EQUIPMENT

254 Plug-In Busway — Twenty-pp Bulletin GEA-6470 describes the factory-assembled Flex-A-Power plug-in busway system permitting direct connection to bus bars for feeding lighting and power loads in industrial plants and public buildings. Describes in detail the construction and application of this busway system. Also lists ratings, weights, dimensions, installation data and guide form specifications. General Electric Co.

255 Testing Instruments — Bulletin 19–56, 16-pp, features company's electrical testing instruments, including ohmmeters, ground testers, dielectric test sets, motor rotation tester, cable fault locating equipment, transformer turn ratio test sets, corona test equipment, frequency meters, tachometers, others. Includes photos and descriptions of each type, including chief features, operating ranges, and applications. James G. Biddle Co.

256 On Copper Conductors — Publication C-25, 62 pp, is designed to help make the selection of bus conductors easier. Included in booklet are tables regarding such shapes as channels, ventilated square tubes and round tubes. There are tables for other rigid bus conductor shapes, also data on bare copper wire and cable as well as commonly used alloy wires. Also provided is a general discussion of copper, its physical and electrical properties. Photos illustrate many installations. The American Brass Co.

257 High-Power Batteries — Bulletin CP-538/55 covers company's line of Hi-Power batteries for use in the control, switchgear, emergency lighting and auxiliary power fields. Includes data on battery ratings and capacities, details of design and construction, dimensions, weights and types of containers. C & D Batteries, Inc.

258 Fuses for All Uses — This revised edition of manufacturer's Complete Line Folder 3 includes illustrations and descriptions of fuses for every purpose. Features dual-element cartridge fuses for time-lag in protection against overloads, and delay renewable fuses and renewal links. Economy Fuse & Mfg. Co.

259 Cable Compound — Test Results and service records on an improved butyl rubber compound for high-voltage cables are announced in 12-pp Bulletin EB-27. Covers resistance to ozone, operating temperature, high-voltage, dielectric strength, aging, insulation resistance, mechanical moisture absorption, electrical moisture absorption, capacity and power factor. Diagrams, charts and tables amplify text. Anaconda Wire & Cable Co.

INSTRUMENTS AND CONTROLS

260 Metering and Control Equipment — Sixteen-pp Bulletin 18 is a comprehensive catalog offering information on company's meters, control equipment and

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FIG. 17-28 Cylinder

FIG. 213 Flanged

FIG. E-57 Double Window

FIG. 212 Visibility Welding Neck or Screw

FIG. E-811 Flapper

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engineering services. It is written for engineers in power plants, public utilities and process plants. Fifteen measured variables common to power and process operations form the index for selecting appropriate equipment. Bailey Meter Co.

261 Boiler Feed Control — Bulletin 1003, a 12-pp catalog on boiler feed regulators, is illustrated with large application photos and detailed schematic drawings and charts. Relay and direct operation are covered. Case studies of representative boiler loads are presented to show stability of the Flowmatics in controlling feedwater. Copes-Vulcan Div., Blaw-Knox Co.

262 Instruments, Controls — Condensed Catalog 1537 offers brief application information on manufacturer's line of instruments. Fully illustrated, covers draft and pressure instruments, flow meters, liquid levels and pressure gages, CO_2 meters, pneumatic transmitters, positioning operators, temperature instruments, boiler feedwater controls, others. Includes references to detailed literature on each type of equipment. Republic Flow Meters Co.

263 Resistance Temperature Detectors — In 8-pp Publication 3016D are described a line of remote temperature-sensitive elements for use in indicating, recording, controlling and monitoring equipment. Operation, application and construction details of the resistance temperature detectors are presented, along with specifications and ordering tips. Instrument Div., Thomas A. Edison, Inc.

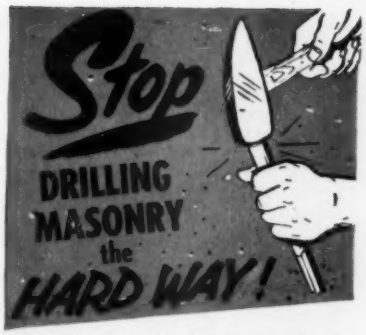
264 Ideas on Push-Pull Controls — Included in this "Idea File" are answers to a power engineer's questions on the use of push-pull controls. A general information booklet discusses remote control applications, explains construction and operation of company's Tru-Lay controls. Separate bulletins are devoted to standard assemblies, bracket-type head controls, micro controls and hand-operated controls. Automotive and Aircraft Div., American Chain & Cable Co., Inc.

265 Steam Calorimeter — This bulletin discusses an improved U-path calorimeter combining a throttling, separating and re-evaporating calorimeter in a single chamber. Explains construction and operation of unit. Ellison Draft Gage Co., Inc.

266 Bi-Color Gage — Bulletin 1174 gives advantages of company's Multi-Port bi-color gage made for boiler operating pressures to 3000 psi. Points out chief design features, illustrates construction details through photos and drawings. Installation methods are also treated. Diamond Power Specialty Corp.

267 Indicating Flow Meter — Bulletin 18-A, 22-pp, discusses advantages, construction and operation of company's Type H indicating flow meter. Presents technical data on the principles and theory of fluid measurement and discusses orifice type meters and orifice meter principles. Offers examples of flow rate calculations. Schematic drawings and diagrams, tabulated technical data and specifications are included. The Meriam Instrument Co.

268 Solenoid Pilots — Several types of solenoid pilots for use with company's regulating valves are described in Form 1010. Lists reasons for economies in on-off control, describes applications, and gives type of pilot, material of construction, maximum pressure and maximum temperature for two- and three-way pilots in steam, air, gas and liquid service. Sche-



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matic diagrams of typical applications are given. Spence Engineering Co., Inc.

269 Easy Reading Gage — An all-hydrostatic remote reading gage for boiler water and other liquid levels is described in Catalog 500, Section CO. Pictures improved visibility, other advantages offered by this gage, explains operation. The Reliance Gauge Column Co.

270 D-C Amplifier — Twelve-pp Bulletin MSP 111.1 provides pictorial diagrams and descriptive information on company's PowrAmp Model P, an electronic low-voltage linear amplifier designed to increase the speed and accuracy of low level d-c voltage measurements. Discusses performance and construction features of the amplifier, and describes some applications. Hagan Corp.

LUBRICATION

271 Turbine Lubrication — The special problems of turbine lubrication are discussed in 8-pp Bulletin TU-1. Tells how purifiers keep power units in service; discusses inhibited and uninhibited oils, company's process for reducing sludge formation within lubrication system. Illustrated with diagrams of typical installations. DeLaval Separator Co.

272 Bearing Lubrication — Vol. XL, No. 10 of this company's Lubrication magazine provides an excellent 12-pp article on industrial bearing lubrication. Illustrated with photos and drawings, text covers such subjects as bearing design; bearing surfaces; bearing overhaul; aspects of lubrication, including factors involved in choice of turbine oils and diesel lubricants, and the deleterious effects of moisture; and the life expectancy of bearing lubricants. The Texas Co.

273 Versatile Industrial Oil — Described in 20-pp Form AD 4078 is an all-purpose oil offering protection for a wide range of industrial equipment, and available in 15 viscosity grades. Discusses six major characteristics of the oil; explains and pictures its use in hydraulic systems, speed reducers, air compressors, electric motors, hydraulic turbines, bearing systems, etc. A chart shows grades available, uses, properties. Standard Oil Co. (Ind.)

274 Lithium Soap Greases — This product information bulletin details qualities and specifications of company's multi-purpose lithium soap industrial greases. Advantages of multi-purpose grease use — such as prevention of lubricant misapplication, simplified maintenance procedures discussed, together with performance characteristics. Sinclair Refining Co.

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OTHER EQUIPMENT

275 Preheating Combustion Air — This well-illustrated 36-pp booklet explains fuel savings and increased performance made possible by using waste heat in flue gases to preheat incoming combustion air. Also covers increased boiler output, ability to use lower grade fuels, other advantages afforded. Booklet contrasts regenerative with recuperative preheaters; explains operating principle and structural details of the Ljungstrom air preheater. Applications for other than power boilers are also covered. Air Preheater Corp.

276 Product Guide — Manufacturing facilities for company's line of steam turbines, turbine generators, ship propulsion units, feed pumps, centrifugal compressors, blowers, centrifugal pumps, reduction gear, and other products are described in this profusely illustrated 50-pp catalog. Photos show manufacturing procedure. De Laval Steam Turbine Co.

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277 Steam Condensers — Some recent additions to this company's power plant condenser installations are pictured and described briefly in this 24-pp booklet. Also included are an engineering section on condenser design factors, and sections devoted to air removal equipment, to steam condenser specialties, and to maintenance services available. Condenser Service & Engineering Co., Inc.

278 Steam Turbines — The advantages of company's solid wheel turbines, axial flow turbines, single stage and multi-stage, are outlined in illustrated Bulletin S-140. Describes various models in their line and includes application photos. The Terry Steam Turbine Co.

279 Turbine Speed Control— Thirty-pp wire-bound Bulletin H-21 is titled, "Fundamentals of Turbine Speed Control." It is an elaborately illustrated, educational booklet intended to clarify the operation of common types of automatic

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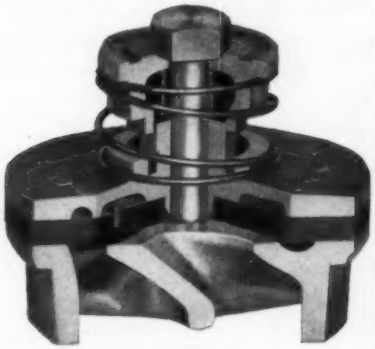

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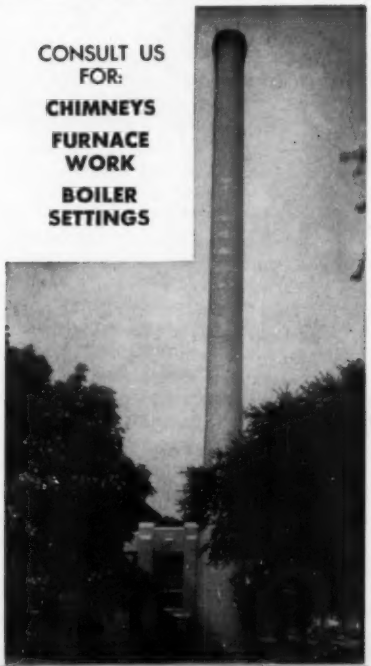

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speed control for steam turbines. An introductory section covers general fundamentals of automatic control systems, and includes a key to control terminology. Simplified diagrams show operating principles of actual control systems. Elliott Co.

280 Heat Transfer Apparatus — Condensed Bulletin HT-1 highlights representative products in company's line of heat transfer equipment. Includes oil heaters and coolers, strainers, evaporators, heat exchangers, radiafin air coolers, tubes, pipes, and coils. Cross-section views of typical units are shown; brief descriptions given. Schutte and Koerting Co.

281 Packings and Gaskets — Catalog P-100C, 32 pp, covers 95 most popular packings and gaskets in company's line, furnishing details of construction, service recommendations and size information. Includes charts showing applications. Packing Div., Raybestos-Manhattan, Inc.

282 Conveyor Belt Chart — Engineering data for standard conveyor belt constructions is given in this chart and accompanying sheet. Strength characteristics of eight popular ply and material combinations of conveyor belt constructions are provided. Each property is printed on the chart in a different color to facilitate comparison. Quaker Rubber Corp., Div., H. K. Porter Co., Inc.

283 High Temp Compound — This folder describes Thred-Gard, a high temperature compound designed to eliminate seizing and galling and lubricate threaded surfaces. Tells its use as thread lubricant and in other applications in power plants, others. Crane Packing Co.

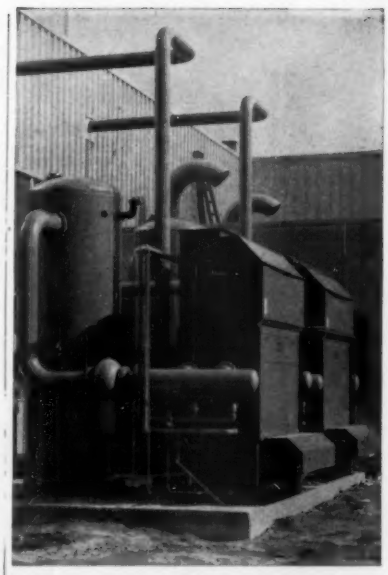
284 Technical Refrigeration — Twelve-pp Bulletin 754 covers a complete line of environmental testing and processing equipment. Provides illustrations and specifications on recently redesigned altitude, humidity, low temperature and prefabricated test chambers as well as specialized testing equipment. Includes helpful engineering data. Bowser, Inc.

285 Corrosion, Abrasion Control — Modern practices and products for the positive protection of metal equipment from the effects of corrosion and abrasion are described in this 16-pp bulletin. Covers factory and field application of rubber or synthetic linings to metal parts or products, and maintenance coatings available for application by plant personnel. Goodall Rubber Co.

286 Sectional Condenser — Bulletin 131 shows benefits of sectional-design refrigeration condensers for 100 to 240 tons refrigeration capacity and explains their functions with diagrams and installation photos. A cutaway shows component parts. Niagara Blower Co.

287 Precipitation Products — Twelve-pp Bulletin G406 contains helpful information on company's various precipitation products, including electrical precipitators, multiclone mechanical dust collectors, combination multiclone-precipitator units, Dualaire filter-type dust collectors and Holo-Flite processors. Also illustrates a number of typical installations. Western Precipitation Corp.

288 Pyrometers, Thermometers — Bulletin GEC-1324A describes features, accessories, application, specifications and special calibration of instruments for temperature indication and control of industrial processes. General Electric Co.



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NEW ENGINEERING BOOKS

Proceedings of the American Power Conference, Volume XVII, 1955. Cloth binding, 722 pages, 9¼ by 6 in. Published by Illinois Institute of Technology, Technology Center, Chicago 16, Ill. Price $6.00.

The American Power Conference is held because many feel the need for a national forum on problems and developments concerning the power industry. The proceedings of the American Power Conference are published for the same reason. They are extremely valuable.

All papers presented at this affair are brought together in the proceedings and cover subjects such as the following:

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Human resources in the technological future
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Gas turbines for power plants
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It is apparent that the subjects discussed range from the state of the industry to the state of the art of many technological fields within that industry. We believe this collection of papers, expertly prepared in book form, to be worth far more than the $6 charge made to cover preparation and printing costs.

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Air Pollution and Abatement Manual, by Manufacturing Chemists' Association, Inc. 12 chapters, 8½ x 11 in.; paper binding, loose-leaf binder. Published by the Manufacturing Chemists' Association, Inc. 1625 Eye St., N.W., Washington 6, D. C., 1954. Price, free to federal, state and municipal officials directly charged with air pollution control; $6.00 to others.

This thirteen-chapter manual has evolved chapter by chapter under the supervision of a sixteen-man air pollution committee of the Manufacturing Chemists' Association. It comprises an encyclopedic summary of the important research work in this field. It has required nearly five years of hard work to bring it to its present state of completion. If anyone believes air pollution control to be a simple subject, leave a copy of this manual on his desk. While it does not strive for complexity, it leaves no doubt that the subject is very complex. Working equations presented with each section bring the discussions down to earth where they can be applied by working engineers.

This book is not limited to discussions of the fly ash problem, but considers all the atmospheric pollutance encountered in industry today. It also considers the atmosphere's role and the atmosphere's behavior in disbursing and diluting these pollutants.

The ultimate aim of this manual is to give aid to industry in achieving abatement of air pollution by the most effective means and at the lowest ultimate cost. It is thought provoking, fairly well written, and extremely useful if air pollution is one of your problems.

★ ★ ★

Framework for Atomic Industry by Herbert S. Marks and George F. Trowbridge — 277 pages — 9 by 11½ in.; flexible plastic binding. Published by the Bureau of National Affairs, Inc., Washington 7, D. C., 1955. Price $12.50.

This book is a commentary on the Atomic Energy Act of 1954. Its purpose is to describe the changes, which the Atomic Energy Act of 1954 makes in prior law, especially as the changes affect the opportunity for private

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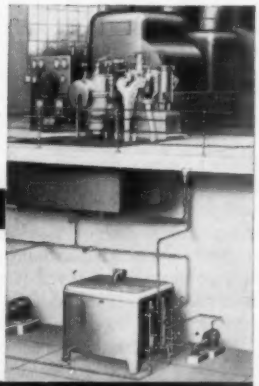

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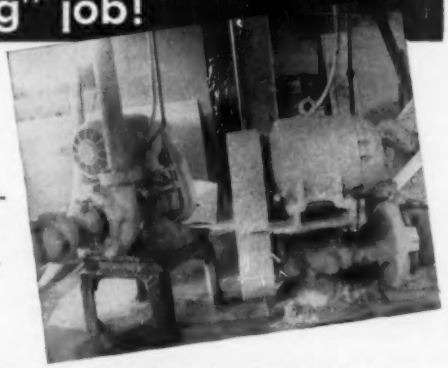

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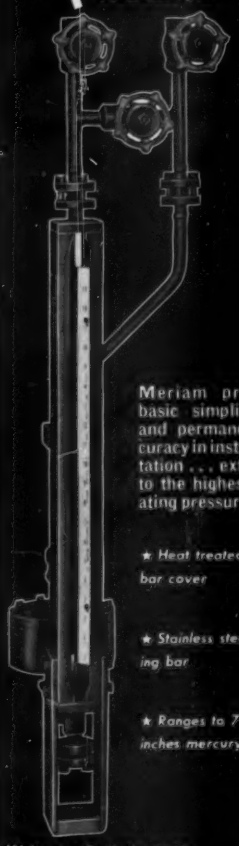

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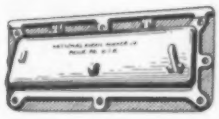

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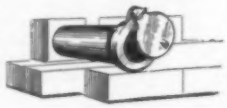

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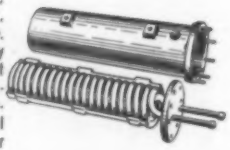

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Engineering Books

continued from page 142

interests to take a larger part in the development of atomic energy. It is divided into two parts.

The first is called "Major changes in the law". It consists of chapters, which describe:

1. The background of the new law
2. The scheme of control of facilities and materials in private hands
3. Control of information
4. Patents
5. Power policy
6. Government aid to industry
7. International activities
8. The function of the Congressional Joint Committee on Atomic Energy; the Atomic Energy Commission and the Department of Defense

The second part is called: "The System of Licensing and Regulation". It consists of chapters which expand the summary chapter in Part 1 on the subject of "Control of facilities and materials".

There are four appendices:

A. The text of the new law

B. The text of the 1946 law

C. Report of the Congressional Joint Committee on Atomic Energy on the new law

D. The statement of the House Managers on the conference report on the new legislation

* * *

General Physics by Oswald Blackwood and William Kelly. Second Edition, 6¼ by 9¼ in., 704 pages, cloth. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 1955. Price $6.75.

This book was written to present the fundamentals of physics clearly and logically. The second edition treats physics as a vital science. It develops topics through the use of the reader's common knowledge and experience. The book's mathematics serve as an aid to understanding rather than an incumbrance. Using simple, direct language, the authors present familiar examples; the automobile, a favorite sport, the human body, television and such things to illustrate the fundamental principles.

The second edition has been almost entirely rewritten. It incorporates a number of changes in design to increase its teaching value. The gas pressure equasion has been modified to explain the molar heats of a perfect gas. The treatment of the Bohr atom has been clarified and expanded, and there is ample discussion of such topics as the equation for the electric potential of a point charge, Kirchhoff's laws, nuclear energy and cosmic rays.

The first edition of this book appeared twelve years ago and went through nine printings. Aside from its value in a classroom, this is an excellent modern book on physics of interest to engineers and technicians in industry.

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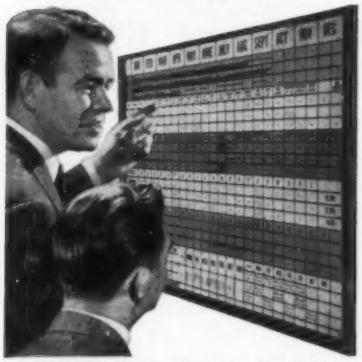

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Atomic Energy Research at Harwell by K. E. B. Jay. First Edition, 5¾ by 8¾ in., 142 pages. The Philosophical Library, Inc., 15 East 40th St., New York, N. Y., 1955. Price $4.75.

This book from the United Kingdom Atomic Energy Authority carries forward the story of the atomic energy research establishment from the point at which it was left in their last book (Harwell — the British Atomic Energy Research Establishment) up to August 1954, when the United Kingdom Energy Authority took over from the minister of supply. It describes the work done at Harwell between 1951 and 1954 and, in addition, changes in the regulation about the release of secret information have made it possible to discuss in more detail some of the subjects, which were only mentioned in general terms in the earlier book.

The author is principal scientific officer at Harwell since 1947.

The book is divided into two parts. Part 1 treats of the major programs of the establishment, and is written primarily for non-technical readers. Part 2 deals in more detail with selective researches and is written for scientific readers, who have not specialized in the various fields discussed.

This is a most excellent book for anyone wishing to know what is being done in the field of atomic energy in England.

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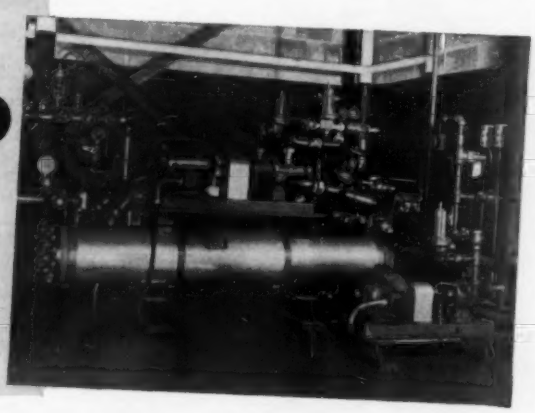

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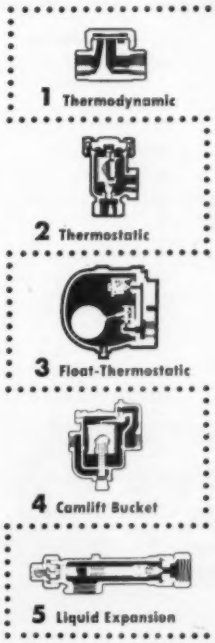

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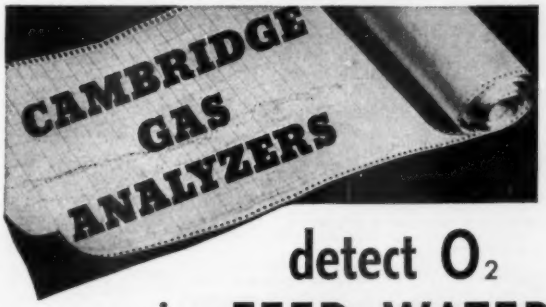

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Agency—W. S. Hill Co.
POWELL VALVES 16
Agency—The Ralph H. Jones Co.
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Agency—Hening & Co.
PRATT, HENRY 136
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Agency—Spooner & Kriegel
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Agency—Carr Liggett Advertising Inc.
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ROTO DIV. OF ELLIOTT CO. 28
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Agency—J. W. Shepard Co.
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Agency—Michel-Cather, Inc.
STANDARD OIL CO. (INDIANA) 49
Agency—D'Arcy Advertising Co.
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Agency—Connor Associates, Inc.
STICKLE STEAM SPECIALTIES CO. 131
Agency—W. H. Rohr, Jr.
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Agency—Harold Cabot & Co., Inc.
STRUTHERS WELLS CORP. ..... *
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Agency—Emery Advertising Corporation
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Agency—Gassaway Advertising Agency
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Agency—Erwin, Wasey & Company Inc.
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Agency—Harold Warner Co.
UNIVERSAL ATLAS CEMENT CO. ..... *
Agency—Batten, Barton, Durstine & Osborn, Inc.
VAN DER HORST CORP. ..... *
VOGT MACHINE CO., HENRY 127
Agency—Farson, Huff & Northlick
W-S FITTING DIVISION, H. K. PORTER CO., INC. ..... *
Agency—W. L. Townes Advertising
WESTERN CHEMICAL COMPANY ..... *
Agency—Carter Advertising Agency, Inc.
WESTERN PRECIPITATION CORP. 129
Agency—Dozier Eastman & Co.
WICKES BOILER CO. 40–41
Agency—Price, Tanner & Willox, Inc.
WILLIAMS GAUGE CO. 133
Agency—Downing Industrial Advertising, Inc.
WILSON, INC. THOMAS C. ..... *
Agency—Michel-Cather, Inc.
WORTHINGTON CORPORATION 119
Agency—Needham Louis & Broby, Inc.
YARNALL-WARING COMPANY 8–9 64
Agency—The Michener Co.

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DO YOU BURN FUEL OIL?

DOES YOUR TREATMENT DO ANYTHING BUT DISSOLVE SLUDGE?

SEEING IS BELIEVING

TAKE A LOOK AT THE TUBES AND HEATING SURFACES IN YOUR BOILERS—If the tubes are covered with a moist soot or if carbon scale is present which can only be scraped off then the treatment you use is not doing a complete job.

SWITCH TO KOR

KOR completely oxidizes all combustible deposits on convection surfaces, superheaters, air preheaters, water walls, economizers, breechings, and stacks; and as a sludge dispersant it defies comparison.

You've Heard About It You've Read About It Investigate and Try It

• *WRITE FOR BULLETIN NO. 1515544* •

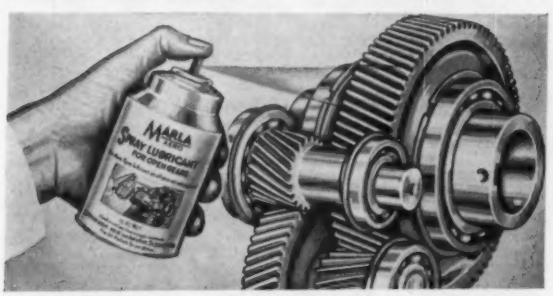
KOR CORPORATION

Division of Oxi Corporation

600 WEST 9th AVENUE, GARY, INDIANA

For more data circle 595 on Post Card

MARLA OPEN GEAR SPRAY LUBRICANT



USE ON ALL GEARS NOT RUNNING IN OIL

Absolutely Nothing Else Like It!

OUTLASTS ORDINARY LUBES 5-to-1

STICKS TO METAL

1. **ECONOMICAL**—Spray container reduces lubrication time. Long lasting film. One can covers approximately 25 sq. ft. of surface with no waste.
2. **HEAVY DUTY**—The finest extreme pressure adhesive lubricant there is for open gears.
3. **EASY-TO-USE**—No fuss . . . no muss. Ease of application encourages and assures complete lubrication of open gears.
4. **CLEAN**—No drip . . . no throw off . . . no clean up of excess lubricant. Will not drip in hot or steamy areas.
5. **SPRAY**—Assures perfect lubrication even to the most hard-to-get-at areas.
6. **HANDY**—Marla Spray Lubricant can be carried easily and is always ready for use. Eliminates the brush, paddle or any preheating.
7. **VERSATILE**—A superior lubricant also for cams, reciprocating actions, mono rails, guides, chains, sprockets and cables.

• PRICES F.O.B. YOUR PLANT

Case of Six — 12-ounce Cans **$10.74** Case of Twelve — 12-ounce Cans **$21.00**

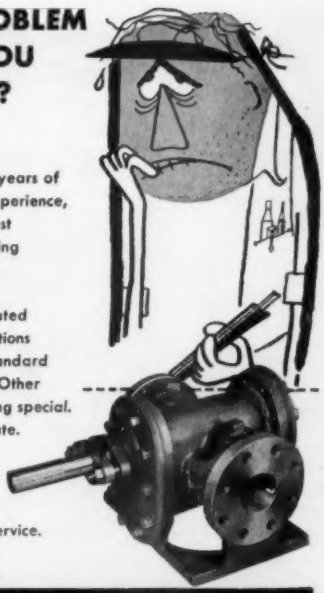
Jobber Inquiries Invited

MANUFACTURED AND GUARANTEED BY

ROTHLAN CORP. • **3618 Laclede Avenue ST. LOUIS 8, MISSOURI**

For more data circle 596 on Post Card

PUMPING PROBLEM GIVING YOU TROUBLE?



Get qualified help.
Tell us about it.
SK Gear Pumps, product of years of research and engineering experience, are solving problems in almost every industrial field—pumping many types of materials like alcohol, fuel oils, glue, wax, lube oils, resins, cellulose, heated oils, road tars. Some applications require only a top-quality standard pump. Ours are top-quality. Other applications demand something special. If so, we're ready to cooperate.

We'd like to get acquainted —let us send you Bulletin 17-A describing our pumps and engineering service. Just write us. We'll send it.

Schutte and Koerting COMPANY

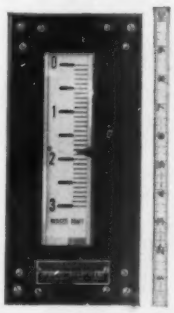
MANUFACTURING ENGINEERS

2221 STATE ROAD, CORNWELLS HEIGHTS, BUCKS COUNTY, PA.

Jet Apparatus: Ask for Condensed Bulletin J-1.	Rotameters & Flow Indicators: Ask for Condensed Bulletin 18-RA.	Valves: Ask for Condensed Bulletin V-1.	Heat Transfer Apparatus: Ask for Condensed Bulletin HT-1.	Gear Pumps: Ask for Bulletin 17-A.

For more data circle 597 on Post Card

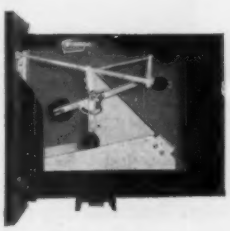
They're Space Savers



Ellison MINIFIED

DIAFRAM ACTUATED STRAIGHT LINE GAGES

- For measuring draft, pressure, differential pressure
- Unitized mechanism slips out front of case
- Internally illuminated
- Standard scale ranges 6″ to 8″ . . . other ranges from 10″ to 40″
- Same foolproof mechanism as the larger standard Ellison Draft Gages
- Non-parallax pointers
- Long service life diafram



Also MINIFIED Receiver Type Gages for Use With Pneumatic Transmitter

Send for Bulletin 215

ELLISON DRAFT GAGE CO.

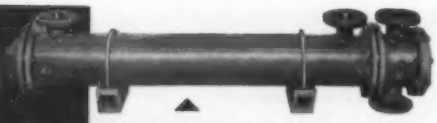
550 W. MONROE BLDG. Since 1896 CHICAGO 6, ILL.

THE ELLISON LINE ALSO INCLUDES:

Draft Gages, Bell and Diafram—Inclined Draft Gages—Portable Inclined Vertica Tube Gages—Vertical Tube Gages—Oil, Heavy Liquid and Mercury—Single and Multi-Tube-Saturator Gages—U Gages—Stationary and Portable—Air Filter Gages—Dial and Inclined Tube Types—Pitot Tubes—U Path Steam Calorimeters—Portable Gas Analyzers-Orsat Type

For more data circle 598 on Post Card

make your headquarters for STANDARD or SPECIAL HEAT TRANSFER UNITS



STANDARD SK Type "BD" Heat Exchanger, two-pass design for service in petroleum, power, chemical processing, and other industries. Also made in single-pass design.

SPECIAL SK Radiafin Air Cooler, one of two large coolers designed and manufactured for a special project. SK welcomes inquiries for special units—willingly offers experienced assistance.

Get Full Details. Write for Bulletin HT-1.

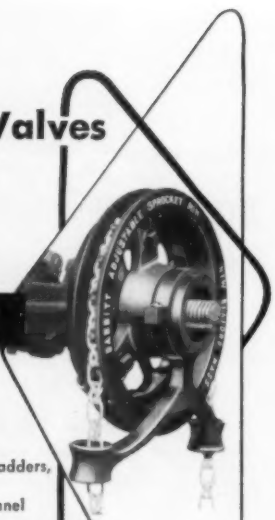
Schutte and Koerting
COMPANY
MANUFACTURING ENGINEERS

2221 STATE ROAD, CORNWELLS HEIGHTS, BUCKS COUNTY, PA.

Jet Apparatus: Ask for Condensed Bulletin J-1.	Rotameters & Flow Indicators: Ask for Condensed Bulletin 18-RA.	Valves: Ask for Condensed Bulletin V-1.	Heat Transfer Apparatus: Ask for Condensed Bulletin HT-1.	Gear Pumps: Ask for Bulletin 17-A.

For more data circle 587 on Post Card

REACH All Overhead Valves without DANGER!
REACH for



Babbitt
Adjustable
SPROCKET RIM
with Chain Guide

- Eliminate dangerous catwalks, ladders, balconies, boxes, stools, etc.
- Prevent accidents, protect personnel
- Reach inaccessible areas easily
- Operate every valve from plant floor
- Easy to install and operate
- No maintenance; first cost, only cost
- Easy instructions with each unit
- Packed, completely assembled, one to a carton
- Fits any size valve wheel
- Your supplier carries complete stock
- Write for new descriptive Catalog sheet and prices:

Babbitt STEAM SPECIALTY CO.
4 BABBITT SQUARE, NEW BEDFORD, MASS., U.S.A.

For more data circle 589 on Post Card

The feather-touch with **DYNAMITE ACTION!**

MORE EFFECTIVE THAN EVER—MARLA AERO SPRAY PENETRATING OIL GIVES YOU THE ADVANTAGES OF:

1. **SPRAY** — Assures penetration, with pressure, to the most hard to get at objects. Shoots a stream three feet if needed.
2. **SPEED** — Always ready at the touch of a button. The fastest acting non acid, non alkali penetrating oil known or money back.
3. **ECONOMICAL** — Spray container eliminates wasted surplus and time in application. Cannot leak or spill.
4. **HANDY** — Carried easily and is always ready for use. No chance for ingredients to weaken by exposure to air from a misplaced cap.
5. **VERSATILE** — Marla Spray Penetrating Oil is used to free the most corroded bolts, screws, pipe threads, bearings, bushings, pulleys, manifolds, valve guides, locks or any other stuck together metal parts.

INDUSTRIAL PACKAGING & PRICE SCHEDULE F.O.B. ST. LOUIS, MO.
Case of Six — 12-ounce Cans . . **$9.00** Case of Twelve — 12-ounce Cans . . **$17.40**

ROTHLAN CORP. 3618 Laclede Ave. St. Louis 8, Mo.
Specialists in Fine Penetrating Oil for Over Thirty Years

For more data circle 599 on Post Card

troubled with **RUST-SCALE** or **CONGESTION** in your water supply systems?

SEND FOR THIS FOLDER TODAY!

SAFE, ECONOMICAL EASY TO USE . . .
Used by thousands of industrial plants, institutions, —including hotels, apartments and other buildings where water is used for drinking and cooking.

The North American
MOGUL
Products Co.
STANDARD BLDG.
CLEVELAND 13, OHIO

40 YEARS OF PROGRESS . . . AND STILL GROWING

For more data circle 594 on Post Card

In the PINK of Condition

CHAPMAN MOTOR UNITS

We've done one thing for you. Chapman's Motor Units . . . for operation of valves, floorstands and sluice gates . . . are in the best of condition for accurate performance and longer, lower cost life.

We've made them as you like them . . . simplified them . . . streamlined them . . . taken off all the fat. In fact, when you look at a Chapman Motor Unit today, you can only find approximately *half as many parts* as on any other unit.

This simplicity, combined with Chapman's traditional ruggedness, means less trouble and lower maintenance over a longer period of smooth, accurate performance.

How can you go wrong? With Chapman Motor Units, the simplified design . . . the sturdy construction . . . mean no drift; less slash, accurate micrometer-controlled limit switch for predetermined seat tightness; quiet motor driven operation at all *times*. All at the lowest overall cost.

No trouble with operating positions. Operation is assured at any angle. Rugged stub-tooth gears need no grease or oil. No trouble with operating conditions. All units are weatherproof . . . *steam tight*. No trouble even with installations. When used with floorstands they are completely wired at the factory . . . ready to connect with your leads. Easy and simple to install.

Get our new catalog . . . Catalog 51 . . . on Chapman motor units today.

The Chapman Valve Manufacturing Co.
INDIAN ORCHARD, MASSACHUSETTS

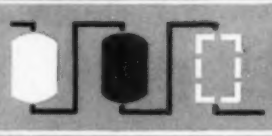
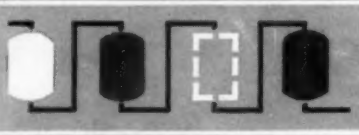
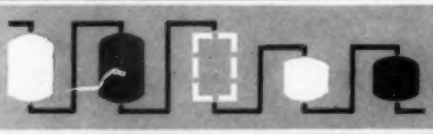
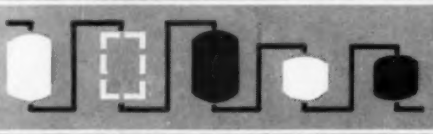
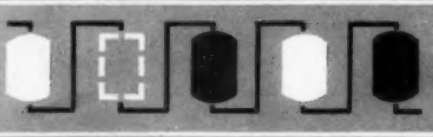
For more data circle 601 on Post Card

9 ways to demineralize water

(BY ION EXCHANGE)

KEY:

- **Hydrogen Cation Unit** — Removes metallic cations such as calcium, magnesium, sodium. Regenerated with sodium for simple water softening.
- **Weakly Basic Anion Unit** — Removes strongly ionized acids such as sulfuric, hydrochloric, nitric.
- **Strongly Basic Anion Unit** — Removes strongly ionized acids, also weakly ionized acids such as silicic and carbonic.
- **Mixed Bed Unit** —Contains both Hydrogen Cation and Strongly Basic Anion Exchangers, intimately mixed.
- **Degasifier** — Optional. Reduces load on Strongly Basic Anion Exchanger by removing free CO_2 brought in by raw water or developed in cation unit.

A	 Effluent Conductivity—10 to 20 micromhos (no silica reduction)	Uses low-cost anion exchanger and anion regenerant (soda ash). Typical use—removing soluble salts from water for ceramic mixes and slips or from rinse waters used before painting, mirror silvering, etc.
B	Effluent Conductivity—same as A. Silica content—0.02 to 0.15 ppm. .	Used for treating feedwater for boilers in general range of 600 to 1400 psi. Also (without degasifier) for removing impurities from plating baths and recovering chromate from plating rinses.
C	 Same effluent as B.	For raw water with high sulfate and chloride content. Low-cost Weakly Basic Anion Exchanger removes major portion of electrolyte load. Countercurrent regeneration of anion units reduces operating costs.
D	 Effluent Conductivity—3 to 5 micromhos. Silica same as B.	For same type of raw water as C. Countercurrent regeneration of both cation and anion units cuts operation costs.
E	 Effluent Conductivity—1 to 5 micromhos. Silica same as B.	For waters where alkalinity is a major part of the anion content. Polishing units require infrequent regeneration. Produces, at low cost, low-solids feedwater suitable for high pressure boilers (over 1400 psi).
F	 Same effluent as E.	High flexibility of operation. Can operate in parallel for peak flows. Can maintain service flow during regeneration of either pair of units.
G	Effluent Conductivity—less than 1 micromho. Silica same as B.	Produces effluent of extremely high quality. Suitable for "super critical" pressure boilers and atomic reactors. (Initial and operating costs are usually higher than for separate anion and cation units.)
H	Same effluent as G.	For raw water with high sulfate and chloride content. Two-step demineralizer reduces load on Mixed Bed unit, cuts operating cost. (Strongly Basic Anion Exchanger is used in place of Weakly Basic where raw water has high silica and alkalinity.)
I	Same effluent as G.	Recommended where alkalinity of raw water is high. Cation unit and Degasifier reduce load on Mixed Bed unit, cut operating costs.

All of the above systems, with equipment and resins made by Permutit, are in commercial use. Other combinations are possible—also use of special ion exchangers such as PERMUTIT SK for separating uranium oxide from other metallic oxides in ore.

Most of these systems (C and higher) are used almost exclusively for demineralizing feedwater for high-pressure boilers . . . but the list of possible applications in other fields is growing.

If you have a problem ion exchange might solve, we'll be glad to study it with you and bring you the benefits of this experience. Address: The Permutit Company, Dept. PE9, 330 West 42nd St., New York 36, N. Y.

PERMUTIT®

rhymes with "compute it"

ION EXCHANGE for Water Conditioning
Chemical Processing • Industrial Waste Treatment

For more data circle 602 on Post Card